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COMPARATIVE PHYSIOLOGY AND PSYCHOLOGY.

BY S. V. CLEVENGER, M.D.

THE science of psychiatry will advance in proportion to the development of psychology based upon comparative microscopic anatomy and a physiology into which molecular physics shall enter more in the future. The entire fabric will be a triumph of monism, for if we set out on any other assumption, such as the dualistic affords, than that mind is a product of chemical energy and other natural forces, there is an end to inquiry.

The baleful influence of teleology hangs over the average physiologist as over the superstitious laity and debars him from seeing things as they really are. The inability to conceive of consciousness as a product of the motions of matter is on a level with the inscrutability of the nature of ultimate force and atoms. In dealing with the workings of the mental mechanism it is not necessary to define or attempt to explain consciousness any more than the practical electrician or chemist or optician finds it necessary to define or speculate upon the ultimate nature of the vibratory terms in which they deal. As the physicist increases his knowledge of *how* matter and motion act and react upon each other, he is willing the metaphysicians should quarrel over the unknowable, the lunar politics. With the dawn of comparative psychology the truth began to appear, theories became subordinated to facts and not facts to theories.

Not only are the laws which bind the social organism similar to and derived from those which govern the units of which it is composed, but the protoplasmic units are governed by the same processes down to chemical affinities.

H. C. Sorby[1] estimated the number of molecules in $\frac{1}{1000}$ inch sphere of albuminous substances to be

Albumen	10,000,000,000,000
Water	520,000,000,000,000
Water in molecular combination	530,000,000,000,000

and claims that we are as far from seeing the ultimate constitution of organic matter with our highest and best powers as the naked eye is from seeing the smallest objects which they now reveal to us, and that there seems no hope that we may ever see them, for light is too coarse.

This is a limit to our sense appreciation of the subject. Reason enables us to make safe guesses beyond the senses, but having them for a guide and acknowledging that science does not require final but effective causes.

The "selection" of food which is suited to the Amœba becomes "selection" or mere chemical attraction depending upon how you look at it. For instance, let the assimilable pabulum consist of molecules for which the protoplasm has affinities or attractions, the Amœba will not only be drawn to it locomotorially, but will fuse about it. As it is drawn into and becomes part of its tissue, there is undeniable chemical union, the inert resulting matter is left behind or excreted in the movements. The inert matter not only does not attract the animal, but even its passing by or over it the assimilative motions are not provoked. There could be an endless wrangle over the nature of this act of the protozoōn, for it involves the most weighty considerations in all life. There is much to be said on all sides, but the moment the acknowledgment is made that chemical affinity and other physical influence is not the so-called will power of the Amœba, that moment there is an end to investigation. Admitting that these natural causes exert entire control of the protozoōn, and forthwith the postulate proves its correctness in exact proportion to the correctness of the logical methods used in reasoning therefrom.

Much of the perplexity into which the student has been thrown by regarding these movements has arisen from want of consideration of the composition of resultants of attraction from many points in the medium or environment due to light, heat, eddies, vortices, disseminated invisible attracting points, the assimilative process itself changing the conditions of attraction, as in plethora;

[1] Presidential address Royal Micros. Soc., Feb. 2, 1876.

as might be expected, movements cease, owing to combinations being satisfied for the time. Then too the simple nature of protoplasm has been by no means proven. It is being regarded as not only complex through atomic union, but as holding in its molecular construction secrets which the chemist may some day find operative in the inorganic affinities. There may be, as has been surmised, many kinds of protoplasm, and the ultimate basic substance may be beyond. The ova of the different animals seem to be protoplasm plus other things, differing from each other in quantities and composition. We know that certain animals add to their bodies chemical substances which form tissues, and that other animals do not, showing a variability of selective affinity. The psychologist who attempts to explain consciousness on the basis of molecular reaction is no more at a loss than the chemist who accepts such words as catalysis and isomerism as representing acts of the atoms.

Starting out, then, with the fair understanding that the Amœba moves by virtue of the operation of physical causes, and that speculations upon the origin of matter and force are foreign to the subject, we will see to what the assumption, if you choose to call it one, will lead.

I invite earnest attention to the proposition I make here as a corollary from the apparent volition of the Amœba being molecular attraction.

Locomotion and prehension of the Amœba are due mainly to extrinsic forces operating immediately upon its organism, whereas these phenomena in man and the majority of the intermediate metazoa are due immediately to intrinsic forces, as a rule, preponderating over the extrinsic, but nevertheless the extrinsic remain the remote causes of motion in all animals.

In this there is a view of the evolution of volition from the so-called involuntary, its growth from the chemical affinities.

The belief is current among biologists that if we reverse the conditions under which all life exists, all life would perish; if the reversal were slowly effected most would perish and but few survive; if inappreciably slowly, it is highly probable that the number of surviving forms would be very large. The survival of any animal is evidence of its consonance with its surroundings, and the environment not only modifies and acts upon the animal to develop or destroy it, but also, from our chemical standpoint,

originates it. Without dipping into biogenesis, spontaneous generation somewhere, somehow, is consistent with the groundwork of our essay, but we will avoid its consideration.

Spallanzani, Dugès, Doyère and others have demonstrated that Infusoria and certain low worms, the Rotatoria, Tardigrada and some Crustacea are capable of desiccation and revival. The suspension of the major evidence of life function by animals under changed conditions, whether this be absolute desiccation or not, the development of seeds and ova, after indefinite quiescence, point toward if they do not fully attest the merging of the inorganic into the organic, and the addition of the faculty known as life through the restoration of the medium which affords the means for the molecular motions which go to make up all there is in life. So the restoration of frozen fish, and as Semper cites: "Amphibia, Mollusca and other forms have lived years without food." He "kept species of land snails for years, wrapped in paper and quite dry, in wooden boxes, and thus wholly without food, and many of them are at this day alive and active." His explanation is: "The amount of nourishment required daily by any animal must naturally be equivalent to the organic matter which is daily used up in the various organs to keep up the vital processes; the more active an animal is the more food will it require. But the vital processes of animals as low in the scale as Amphibia or univalves are extremely feeble; their respiration, even under the agitating influence of propagation, fails to raise temperature appreciably. In such the vital processes may be reduced to a minimum without loss of life."

The whole matter is one of degree, for warm-blooded animals live but a little while unfed. Hibernates are comparable in condition to "cold-blooded," while this division sustain an arrest of nutrition longer, and finally in the lowest forms the approach toward almost indefinite suspension leads us to think that there is a point where life and mere chemical conditions are identical. The repeated withdrawal of that which renders life evident entails no permanent inconvenience. Such embryos as are capable of living in a medium such as strong alcohol several days, point to the mechanical nature of certain low stages of life and the diminished liability to destruction of initial forms through heterogeneity of environment. The internal tissues of man, with their great range of chemical natures of fluids in which the cells

thrive, instance this. With differentiation and higher organization comes the increased necessity for stability of environment, paralleled by the ability of low forms to reproduce lost members, not evident in developed life.

We may regard the Amœba in many ways as having undergone development above some lower form; but pending the settlement of the bathybius question, and with a mere glance at Protista and preamœbic life, the organism affords us a convenient starting point for inquiry. While physiologists agree in its possession of the fundamental activities of life in simplest modes of manifestation, they usually content themselves with a mention of this fact and proceed to examine complex differentiated tissues as though the Amœba merited no further attention. From my way of looking at it, the Amœba, containing the solution of so much, deserves very deep consideration, which being accorded it, the apparently simple becomes intricately complex in that it explains so much.

First the environment of the Amœba: Stagnant water, mud or damp earth, or from the infusion of any animal substance in water and allowing it to evaporate while exposed to direct sunlight.[1]

It absorbs oxygen and gives out CO_2. 45° C. and strong shocks of electricity kill it; moderate shocks of electricity causes it to assume the globular still form. Crushing kills it and then even the nucleus disappears. Freezing point arrests motions. In its surroundings there are, besides its food, air, water, mineral matter, sunlight, heat and cold, mechanical vibrations.

At 35° heat stiffens it, at once proving the development of the Amœba for its medium, and that of the white blood corpuscle, which is more sluggish, for a different one, the temperature of the blood currents of the different animals. This may be regarded as an acquired adjustment.

Its molecules are subject to the law of gravitation. Light attracts it; heat increases, within limits, its activity; vibrations, such as eddies of its medium, move it; electricity stuns it; its intimate structure assimilates, chemically, the substances for which its molecules have affinities, and being nonresponsive to those for which it has not, consigns them to the exterior.

Now if all these forces act upon and in the Amœba, what is to prevent external forces from pulling or pushing out its pseudo-

[1] Practical Biology, Huxley and Martin.

podia, and with the cohesion of its mass flowing its granules into the pseudopodium most attracted, and thus drawing it bodily in the line of the resultant of all its external and internal forces. The multiplicity of the components of the resultants are evident upon watching it.

However highly differentiated the desires of man may be, and however he may fail to recognize the attraction of his own cells for pabulum, as soon as the food is placed within reach of the enteric cells, *their* affinities are not masked. If a complex organic protoplasm has the capacity of chemical conversion and union with oxygen and other molecules, and at the same time the union of oxygen with hydrogen under the proper circumstances is through such conditions which favor the mutual attraction at a distance, we cannot avoid the idea that a similar effect is produced upon the bioplasm, and that affinity for its food is a chemical energy which is one of the forces forming, with other modes of motion or attraction, a resultant, each of these attracting inversely as the square of its distance, and directly as its mass. Because the protozoön does not go straight toward its food, it is thought not to be attracted by it, but when in contact the pseudopodia envelop it, then it is said to be a will effort. When in contact then the assimilation is possible and chemical energy asserts itself as a larger component of the general forces which make resultant motions, when at a distance the food becomes one among many influences upon its movements.

Prehension, which is here evidently locomotory, is for the obtaining of food, and is caused by a number of natural extrinsic forces or attractions combined with a lesser number of intrinsic forces or attractions.

Chemical affinity is the prime cause of assimilation. Locomotion is evidently here only a form of the latter, due to the former as a direct cause, not accidentally aided, often interfered with, by other similar natural forces, inasmuch as the Amœba may be drawn away from his food unless it be near enough, or there be a compensatingly large enough amount to draw it against opposing attractions.

Throughout animal life to the highest with the development of food-procuring faculties this rule still holds good. The more the faculties increase the more direct is the food acquisition and the less do generally coöperate, but in this regard interfering

forces influence food procuring. Atavism is prominent in doing that which drives from a base of supplies or want of foresight in improvidence.

Prehension is an accessory to locomotion, and both are assimilative acts, or acts which have for their end the assimilative.

This also is evident in full development, for every act or movement of the body is of a prehensile nature. Leg movements take hold of the ground through gravitation to carry the body in search of food; hands and arms being directly prehensile; jaws are prehensile in their food grasp; ribs are prehensile in their assisting oxygen introduction, that gas being a food. In snakes the ribs are locomotory prehensile.

We thus have all the physical forces, including gravitation and chemical energy, acting upon the low organism to cause *all* its motions. Just as the heat of the sun overcomes by its gravity the earth's, and lifts billions of tons of water from the ocean to allow it to fall again in obedience to terrestrial attractive force, so may the "vitality" of an animal or plant, *apparently* working against physical laws, lift the child from the embryo, the tree from the seed, but eventually the cycle is complete and the primitive elements are separated in "death" to reënter at once upon other changes. The natural forces are masked in life-phenomena as the law of gravitation is, though the direct agent, not recognized in the upward rush of the fountain.

The Amœba assimilates organic matter and breathes as it uses up oxygen and exhales carbonic acid. To complete the objective study of the Amœba we observe that it *grows* as a consequence of its eating, and that owing to its growth and the operation of the attraction of gravitation, a force too often neglected in consideration by physiologists, *fission or reproduction* occurs, as the cohesive attraction of its molecules cannot pass beyond a certain limit, and the extra weight is gravitated, *excreted* off, a process still evident in all animal reproduction and through excretory channels also.

We also see that the sexual act is *identical* with eating in the so-called neutral, genuine hermaphrodite, form. This is more apparent in other Protozoa as a differentiation. I append my article on this subject from *Science* (N. Y.), June 1, 1881:

A paper on Researches into the Life-history of the Monads, by W. H. Dallinger, F.R.M.S., and J. Drysdale, M.D., was read before the Royal Microscopical Society,

Dec. 3, 1873, wherein fission of the monad was described as being preceded by the absorption of one form by another. One monad would fix on the sarcode of another and the substance of the lesser or under one would pass into the upper one. In about two hours the merest trace of the lower one w is left, and in four hours fission and multiplication of the larger monad began. A full description of this interesting phenomenon may be found in the *Monthly Microscopical Journal* (London) for October, 1877.

Professor Leidy has asserted that the Amœba is a cannibal, whereupon Mr. J. Michels, in the *American Journal oj Microscopy*, July, 1877, calls attention to Dallinger and Drysdale's contribution, and draws therefrom the inference that such cannibalistic act of the Amœba is a reproductive one, or copulative, if the term is admissible. The editor (Dr. Henry Lawson) of the English journal, Oct., 1877, agrees with Michels.

Among the numerous speculations upon the origin of the sexual appetite, such as Mandeley's altruistic conclusion, which always seemed to me to be far fetched, I have encountered none that referred its derivation to *hunger*. At first glance such a suggestion seems ludicrous enough, but a little consideration will show that in thus fusing two desires we have still to get at the meaning and derivation of the primary one—desire for food.

The cannibalistic Amœba may, as Dallinger's monad certainly does, impregnate itself by eating one of its own kind, and we have innumerable instances among Algæ and Protozoa of this sexual fusion appearing very much like ingestion. Crabs have been seen to confuse the two desires by actually eating portions of each other while copulating, and in a recent number of the *Scientific American* a Texan details the *Mantis religiosa* female eating off the head of the male Mantis during conjugation. Some of the female Arachnida find it necessary to finish the marital repast by devouring the male, who tries to scamper away from his fate. The bitings and even the embrace of the higher animals appears to have reference to this derivation. It is a physiological fact that association often transfers an instinct in an apparently outrageous manner.

With quadrupeds it is undoubtedly olfaction that is most closely related to sexual desire and its reflexes, but not so in man. Ferrier diligently searches the region of the temporal lobe near its connection with the olfactory nerve for the seat of sexuality, but with the diminished importance of the smelling sense in man the faculty of sight has grown to vicariate olfaction; certainly the "lust of the eye" is greater than that of other special sense organs among Bimana.

In all animal life multiplication proceeds from growth, and until a certain stage of growth, puberty, is reached, reproduction does not occur. The complementary nature of growth and reproduction is observable in the large size attained by some animals after castration. Could we stop the division of an Amœba, a comparable increase in size would be effected. The grotesqueness of these views is due to their novelty, not to their being unjustifiable.

While it would thus seem apparent that a primeval origin for both ingestive and sexual desire existed, and that each is a true hunger, the one being repressible and n higher animal life being subjected to more control than the other, the question then presents itself: What is hunger? It requires but little reflection to convince us of its potency in determining the destiny of nations and individuals and what a stimulus it is in animated creation. It seems likely that it has its origin in the atomic affinities of inanimate nature, a view monistic enough to please Haeckel and Tyndall.

Dr. Spitzka, in commenting on the foregoing in the same journal, June 25, 1881, says:

"There are some observations made by alienists which strongly tend to confirm Dr. Clevenger's theory. It is well known that under pathological circumstances relations obliterated in higher development and absent in health, return and simulate conditions found in lower and even in primitive forms.

An instance of this is the *pica* or morbid appetite of pregnant women and hysterical girls for chalk, slate pencils and other articles of an earthy nature. To some extent this has been claimed to constitute a sort of reversion to the oviparous ancestry, which like the birds of our day sought the calcareous material required for the shell structure in their food (?). There are forms of mental perversion properly classed under the head of the degenerative mental states with which a close relation between the hunger appetite and sexual appetite became manifest.

Under the heading "Wollust, Mordlust, Anthropophagie" Kraft-Ebing describes a form of sexual perversion where the sufferer fails to find gratification unless he or she can bite, eat, murder or mutilate the mate. He refers to the old Hindoo myth of *Civa* and *Dúrgá* as showing that such observations in the sexual sphere were not unknown to the ancient races. He gives an instance where after the act the ravisher butchered his victim, and would have eaten a piece of the viscera; another where the criminal drank the blood and ate the heart, still another where certain parts of the body were cooked and eaten.[1]

Nature, London, commenting on my article, quoted. "Mulieres in coitu nonnunquam cervicemque maris mordunt," from Ovid, I suppose.

The locomotory, which exhibits all the prehensile acts undifferentiated, is a product of a number of natural forces, and so far as we can speak of atoms having objects, the object of locomotion is food procuration.

Prehension, locomotion, assimilation, growth, excretion, reproduction are so combined as to appear inseparable, all are molecular motions integrating to form mass motions, and the latter to facilitate the first.

Keeping this in sight as a biological fact it will simplify subsequent inquiry.

Adjustment and readjustment of the animal perpetually occurs, the reaction of the protozoōn upon its environment is possible only through the intimate structure of the animal having been modified by the environment, this consists in molecular changes ending in mass changes.

This tendency is exhibited in the frequent appearance of a part unable to throw out pseudopodia, which gravitates to the rear

[1] Ueber gewisse Anomalien das Geschlechtstriebes. Von Kraft-Ebing. Arch. f. Psychiatrie, VII.

and thus becomes the hinder part, this occurs in the proteus animalcule temporarily, and in other Amœba forms as a permanent differentiation.

The ectosarc is composed of denser but mobile material due to separation of granular and molecular matter by natural causes.

The vacuoles are with reason assumed to be watery or gaseous spots filtered from the assimilative process, their constant appearance and disappearance are doubtless chemical and mechanical. The CO_2 and water holding in solution or suspension fine excretory material will find its way out through diffusion, and the elasticity of the sarcode with other larger particles gravitated out through any temporary channel. This process is apparent, though better provided for, in cloacal animals whose watery, gaseous and solid excreta are poured forth from fixed, often the same orifices. The gastræa stage is this condition in full.

If with ingestion of food and oxygen the animal increases its bulk faster than the ectosarc can accomodate itself to the change, extraneous matter, such as carbonic acid and water, *must* be propelled away from the protoplasm for which it has no affinity, and under the operation of incessantly recurring similar causes it is not surprising that this rythmical diastole and systole should often become quite regular.

We thus have inspiration of oxygen as an assimilative act in its affinity for the protoplasmic molecules together with the other accretive atomic motions and elasticity of the ectosarc instituting rythmic contractions to expel inert products. If this be admitted then *the inspiratory oxygenation of every enteric and arterial cell from the food and blood is the direct cause of vermicular motion and pulsation.*

The motions of the Amœba are assimilatory, prehensile locomotory, accretory, inspiratory, expiratory, excretory, reproductory.

Turning now from the objective method let us examine this primitive form subjectively. The objections to an application of the latter process to amœbic movements are equally valid against all other animals, even man. We know nothing of the workings of consciousness in others except by comparing like effects and inferring from them similar causes. We have the various molecular and molar workings of the Amœba as a guide in determining what it feels, likes and dislikes. Descartes' conclusion,

"Cogito ergo sum," Huxley regards as "non sequitur." I would merely postulate both ends of the sentence as being for physiological study, unassailable: "Sum et cogito," and let the metaphysicians wrangle over the rest. The Amœba's functions are simple but nevertheless the same as our own. Forthwith we must assign it a desire for food, which desire is the chemical affinity of atoms, then the Amœba hungers. This, Professor E. D. Cope[1] assigns as "the primitive desire and a form of pain. This was followed by gratification, a pleasure, the memory of which constituted a motive for a more evidently designed act, viz., pursuit."

Dividing primitive desires arising from (or with, if you wish) the atomic affinities into those which subserve and those which oppose assimilative processes, we have the origin of pain and pleasure, under which two heads all conscious workings may be classed.

Pain increases with the quantity of atoms unsatisfied. As long as there are protoplasmic molecules with affinities, the number of them wanting food increases the desire (attraction directly as the mass). Of course as soon as destructive starvation breaks down the molecules the desire ceases.

This is evident in the final loss of desire for food in extreme deprivation in man.

All unsatisfied desire is painful, as:

Hunger in the absence of food.

Desire to move about while disabled from so doing.

Desire to excrete when prevented by any cause.

In the act of satisfying desires pleasure is apparent:

Hunger appeased.

Movement unconstrained.

Emunctories unobstructed and excretion active.

All pains and pleasures are relative and intense in proportion to the precedence of one or the other extreme.

The pangs of parturition are obstructive excretory, and what obstetrician has not noticed the happiness of accomplishment by the mother.

A pleasure is often wholly due to the preëxistence of pain, and bearing upon the evolution of the reproductive excretory cellular into a desire which in its influence upon animal life is second

[1] Origin of the Will, *Penn Monthly* for June, 1877, p. 446.

only to that of hunger, this relativity must be borne in mind. The pleasurable anticipation of eating is a memory, the physical basis of which in the Amœba is a motion of the molecules involved in assimilation; their activity, their tension (the hungry Amœba is always more active than when fed). The reproductive excretory is in the Amœba scarcely to be called a desire, so dependent is it upon the performance of the assimilative act. The desire is invoked in exact proportion to growth from assimilation, provided other means of consumption of this growth are not operative.

This is obvious throughout all animal life. When hunger is extreme the sexual desire is absent. Full meals sometimes excite voluptuous feeling. The repression of this excretory desire for a time becomes painful until readjustment enables vicariation. The desire to excrete the sperm cell is the male peculiarity, the desire, when present, of the female being, as shown in the *Science* article, identical with hunger. It is the hunger of the ova which are part of the female and which by differentiation have come to be capable of satisfaction in the manners to which they have grown.

From the synamœba stage, with its denser envelope preventing the escape of the cells for a longer period this sexual excretory desire would increase differentiation of the sexual hunger from the general hunger, is shown in the Drysdale and Dallinger monad.

C. M. Hollingsworth[1] on the "Theory of Sex and Sexual Genesis," assigns causes determining sex: "Since germ cells are large and sperm cells are small, it may be at once inferred that where they are formed in different parts of the organism, the parts in which germ cells or their producing organs are formed, must be parts in which the conditions are especially favorable to nutrition; and that the parts in which sperm cells or their producing organs are found, must be relatively unfavorable to nutrition and favorable to cell division."

"The hypothesis is that a *relative* preponderance of the conditions on which cell division depends causes the formation of the female or male generative organs, or determines the sex of the individual."

Extending this to the Amœba the pure relativity of sex is seen.

[1] American Naturalist, July and August, 1884.

If the Amœba had undergone differentiation above some form by which it was engulfed, it could be regarded as the male. If it were swallowed by a synamœba then it is the female cell, and the product of this sexual eating would be either male or female—synamœba or amœba according to the preponderance of differentiating influence or the disposition to increase by fission on the resulting fused mass.

Desires consisting of atomic tensions or affinities, the conditions of continuance or satisfaction of desire, involves feeling or sensation, a low form of consciousness; this is justified in considering our developed similar states during the same processes of hungering, eating, etc., and as in us repletion discontinues desire, so does it in the lowest form of life we are discussing.

The sensations involved in assimilation would be difficult to separate from those concerned in pseudopodia-protrusion or general locomotion, as they are identical in effect in the Amœba; admitting their identity, it is easy to see how, by invagination of the ectoderm the later differentiation could occur by an enteric tactile developing in one direction while the ectodermal would change with direct reference to locomotion or prehension. But, as even when the enteron is formed, a prehensile tactile sense is retained and developed, analogies between the same distributions to external and internal parts remain though the sensations in many respects differ. The passage of materials in the intestines awaken few feelings so long as the adjustment is not disturbed, on the same principle that we do not feel external ordinary stimuli perpetually recurring.

Pressure is the feeling of constraint, interference with molecular and mass movement, it is a painful state of consciousness arising from the inhibited movements, the desire to move being consequent upon proper assimilation, and is referred to an interference with that function.

The hunger pain and appeasing hunger pleasure are due to and consist in chemical tensions and release from tension, the absence and presence of certain molecules. This carried up the scale of Metazoa convinces us that desire, feeling, sensation reside *in every living cell in the body*, and are not seated exclusively in nerve tissue. With the differentiation of function there will proceed changes of degrees of intensity of certain feelings in those living cells, but the fundamental hunger pain and pleasure of its gratification are never differentiated out of existence in any cell.

Desires, feelings, sensations, consciousness, cognitions, ideas, memories, emotions, etc., are one and all *conditions* of the molecules of the cells, and in the ravenous though unavailing appetite of some diseases wherein nutrition is at fault, the feeling is shown not to be solely located in the intestines but all over the body, and the inability of physiologists to locate centers for desires in the brain is explained. Whenever the exhibition of a feeling or a feeling itself has been destroyed through injury, it has been through failure of the *tracts* which convey molecular movements generated by such feelings from the now nervous bodily cells wherein those feelings are highly developed. *The nerves are pure association systems, and where the feeling aroused in an organ had become, through constant repetition, associated with certain other feelings or with a motor expression, then nerves of association would be built up through least resistant lines.*

The organism consisting in the sum total of the life activities of its cells, the dissociation of the organism from its locomotory organs, the legs, cut off the ability to walk, and paralysis of strands leading to the legs dissociate similarly.

Cutting off the organ of special sense or destroying its tracts similarly dissociate. There is a difference between cells acting for themselves or acting unitedly with others.

Returning to our Amœba, the mobile granules and molecules moved with every impulse. Its sensations were motions and its motions sensations, the two were inseparable. With a change in the density of its ectosarc, retarding fission, the morula form arose and in the break of the envelope Amœbæ are, as might be expected, liberated, but they have inherited this molecular development of ectosarc induration and develop into synamœbæ as did its parent.

The planæada developed cilia through a similar law. Owing to the difficulty of withdrawing pseudopodia once protruded, these atrophied into vibratile organs through starvation, and the hunger motions of the cells set up oscillations of the cilia which, subserving the life purposes better, were perpetuated and the motions of the cells adjusted themselves to the necessity and brought the environment food to itself by causing eddies, and a new means of locomotion arose. Still sensation and motion were identical, for the molecular movements constituting sensation ended in their summation of motions into gross locomotory motion, except that

the cilia were organs of locomotion while the body remained sensitive. We may regard the cilium as formed of dead material in the main, Dallinger and Drysdale's monad rejected it in eating its companion. This would shadow forth the possibilities of a set of ciliary vibrations becoming known to the animal as tactile locomotory, differing from, though ministering to, hunger sense, and a change in the aggregation of the cell granules would follow. When the cell granules moved in keeping with the ciliary motions either the locomotory memory or act was aroused, if in accordance with hunger movements then the memory of hunger was aroused and this could react on the cilia to move them. When the ectoderm reached a stage of hardening admitting of no more strain upon it, the central contents transuded by some means, probably temporary rupture. The gaseous and watery contents escaped and the animal collapsed into the gastræada stage. The enteric cilia still remain as originally developed, but of course changes between ectodermal and endodermal experiences would differentiate the two areas. The inner remained subject to constant encounters, or nearly so, and the outer had the brunt of every change.

The acœlomotous Turbellaria appear to me to be more of an aberrant type not in our phylum, many of the forms have undergone much development. The delamination origin of the gastrula stage could be one of those ontogenetic short cuts often made in copying phylogenesis, the end attained being the same.

The Scolecid presents the most evident progress toward development in the vertebrate direction. Its cœlom contains the first nutrient fluid allied to blood, but its circulation is not established. The denudation of the useless external cilia, though occasionally developed into stiff setæ, in a turbellarian follow the locomotory process, changing to that characteristic of worms, elongation and contraction of the body length. Hubrecht's Pseudonematon illustrates this movement, through the alternate contraction of longitudinal and circular muscles with a plexiform nervous system between. The motion is in some respects similar to the flow of amœba granules forward into an arm, but organization has restricted this to a to-and-fro motion. The shape of the body rendering this the easiest mode of progress, the sum of the life activities act in least resistant lines to elongate and then contract the worm. Cause and effect exchange places in the circu-

lar fibers, being placed, through the motion of elongation, in a state of inertia, enabling the contraction of the longitudinal with consequent adjustment of the circular fiber molecules, so they can act to advantage. The repetition of these two opposed motions through the epidermal confinement of the skin, rendering them about the only ones that could be made, initiated by the attractive affinities of the protoplasm, finally developed the contractile tissue. The ventral location of the nervous system in the Errantia and others is due to development through use of that region differentiating locomotor areas from the epidermis, and in Insecta it is the persistence of the phylogenetic origin. In the worm stage the external tactile becomes fully developed through the heterogeneity of molar vibrations to which it is subjected.

One method of locomotion being possible, another is also possible, differences or variations in one or the other, such as could be caused by mechanical means, could result in a sinuous movement arising from want of rigidity in the worm length. A complex of causes, simultaneous and successive, operate to change the usual mode of locomotion and introduce so-called compound reflexes.

The formed tissue, of which Beale speaks, is often excrementitious, and has, through being useful, been retained by the cells. The sandy covering of the rhizopod, *Astrodiscus arenaceus*, may have been " selected " by agglutination of the envelope with the particles, or the shell of a mollusk may form through excretory processes or a covering may be acquired by squatter right as with the hermit crab. It matters little to the animal. The fighting cock will use the steel gaffs with as much gusto as though they had grown from his legs, nor is the cell a particle more particular. If it find in its environment matter with peculiar properties it will, through " selection," eat what it can and excrete the rest. If the excreted material have enough affinity for the cell to remain in its vicinity, and a life process is subserved by that fact, things chemical and mechanical in nature will conspire to associate the material with the cell. I regard nerve granules, such as are found arranging themselves or being arranged into first plexuses of fibers and then definite tracts, as having arisen accidentally. As the rhizopod could not have acquired his overcoat where there was no sand, the ancestral worm which picked up a nervous system could not have done so in the absence of

assimilable phosphates. The resulting nervous system became more and more definite in tract formation as motions became more and more definite between parts. These nerve granules had a molecular mode of action altogether different from anything experienced before by the animal. In higher forms the cell substance, which had the particular ability to excrete or secrete it (relative terms), formed along the area of the plexus and tracts, next an encapsulating membrane formed about it, in obedience to ordinary physiological and pathological processes that an intermediary substance will be attracted and form around tissues or even foreign substances as a resultant of the mode of operation of the two tissues. In due time areas of nerve granule generation find in itself small plexiform areas which are turning points of direction for the molecular nerve discharge, and by encapsulating these the nerve cell is formed, which I regard as having no other functions than a histogenetic one aside from the molecular impacts passing through it. From protoplasm exuding the nerve granules the nerve cells develop to that office; from indifferent tissue forming cartilage, some of the latter form osteal cells.

A plexiform rudimentary nervous system conveys irritations over the body. When the discharges become definite the linear arrangement appears as in the ascidian embryo, the head end developing through tactile and rudimentary sense organs determining there with frontal impact of environment. Most influences acting to excite the squirt or vermicular motions from mouth to anus, a method of locomotion and ingestion at the same time.

It is easy to see how the mechanical perforation of a cœlenterate sac caused the enteron to be completed, but the origin of the circulatory system is not so evident. The enterocœle is in direct communication with the enteron in cœlenterates and the fluid it contains, as Huxley says, "represents blood," it is nutrient; the lacunæ of some worms are the next step toward a blood vascular system. The pseudo-hæmal system of the Annelida contains a substance resembling hæmoglobin, and with these facts before us we may construct the vascular system and its workings in some such way this: Cœlom, a receptacle for a fluid containing nutrient matter which had strained through the endodermal cells and through interstices between them. Next the appearance of hæmoglobin or its equivalent in the cœlom. The peculiar proper-

ties of this substance consist mainly in its solubility by alkaline fluids and its affinity for oxygen, "which is linked to it by ties so easily broken that it can be transferred to other easily oxidizable bodies existing by its side, that it can be given up when its solutions are gently heated in vacuo or agitated at moderate temperatures with large quantities of inactive gases, as nitrogen or hydrogen."[1] This oxygen carrier next formed a cell especially adapted to its transportation.

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SOME APPARENTLY UNDESCRIBED INFUSORIA FROM FRESH WATER.

BY ALFRED C. STOKES, M.D.

THE Infusoria whose descriptions are appended have as yet been observed only in the shallow ponds of Western New York, although they doubtless occur as plentifully elsewhere. Near the pretty village of Olean, in the bosom of the western hills, they pass their little lives amid attractive surroundings. Scarlet clusters of the cardinal flower and great bunches of yellow primroses make brilliant the shores of their aquatic haunts, while tall *Rubus odoratus* holds it purple roses aloft in the warm air, and *Anemone pennsylvanica* lifts its white blossoms above the "lush and lusty grass." A bird chirps in the shading maple boughs, a frog cries and splashes into the pool amid the Myriophyllum and Utricularia; a meditative cow gazes quietly at the intruding biped, and the blue sky bends above, and the blue mists rest in the hollows of the distant mountains. The placid water teems with life. A furrowed Euglena, hitherto undescribed and unseen by the eye of man, rotates like an animated screw in and out among the utricles and leaflets of the water weeds.

This green creature, which I have named *Euglena torta*, bears the remotest resemblance to any known member of its genus. The parenchyma is as usual uninterruptedly green, but the characteristic features are the spiral grooves or keel-like ridges traversing the entire body from anterior extremity to posterior acumination, where they are lost in the origin of that colorless caudal prolongation. The animalcule is but slightly flexible and apparently not changeable in shape during life. After death by poisoning the ridges and

[1]Gamgee's Phys. Chem. of the Animal Body, p. 91.

depressions disappear, and the body becomes smoothly subcylindrical. In life, however, it cannot be mistaken for any known species of the genus. Among the Euglenæ it is unique. Fig. 1 delineates it under a magnification of 360 diameters, and the subjoined description probably contains its essential specific characters.


FIG. 1.—*Euglena torta*, sp. nov. × 360.

Euglena torta, sp. nov.—Body elongated, subcylindrical and traversed by three longitudinal, spirally directed furrows, or three spiral, keel-like longitudinal elevations; anterior extremity rounded and slightly bilabiate; more or less tapering posteriorly and terminating in a colorless, acuminate, somewhat curved caudal prolongation; cuticular surface smooth; endoplasm green; amylaceous bodies usually two, cylindrical, situated one on each side of the spherical, centrally located nucleus; contractile vesicle and pigment spot conspicuous near the anterior extremity; flagellum subequal to the body in length; movement rotary on the long axis. Length of body $\frac{1}{400}$ inch. Habitat: Among Utricularia in shallow ponds in Western New York.

In movement, but in little beside, a Phacus from the same pool resembles *Euglena torta*. This rotation on the longitudinal axis it has in common with *Ph. triqueter*, *Ph. longicaudus*, *Ph. pyrum* and *Ph. pleuronectes*, the other members of the genus, all of which are more or less abundant in still and shallow waters. It is represented in its lateral aspect in Fig. 2, magnified 280 diameters. It may be described as follows:


FIG. 2.—*Phacus anacœlus*, sp. nov. × 280.

Phacus anacœlus, sp. nov.—Body broadly ovate or suborbicular, more or less compressed, the right and left sides concave, the dorsal and ventral margins each traversed by a deep longitudinal furrow, the body thus appearing to possess four keel-like ridges; caudal prolongation colorless, acuminate and curved toward the dorsal aspect of the body; eye-spot and contiguous contractile vacuole conspicuous; flagellum subequal to the body in length, inserted beneath a prominent lip-like projection; endoplasm green. Length of body $\frac{1}{800}$ inch. Habitat: Shallow ponds in Western New York.

All of the Vorticellæ are attractive, but the most beautiful form I have yet met with is one that occurs in some profusion scattered over the rootlets of Lemna from this same rich little pond. At first I was disposed to identify it with Ehrenberg's *V. chlorostigma*, but subsequent study showed that such identification could be justified only by that zoöid's probable coloration. It is considerably more campanulate in form than

the Ehrenbergian species, and has not the densely granulated parenchyma of the latter. In color it is a translucent homogeneous emerald-green. It has a frequently exercised tendency to a characteristic change of form by retracting the borders of one side of the extended body so as to produce a deep depression, while the contracted zoöid exhibits a habit of some slight diagnostic value in the sheathing of the distal end of the pedicel by the posterior extremity of the body. The cuticular surface is transversely striated by depressions so fine that they are ordinarily visible only at the lateral borders or after manipulation of the mirror. Minute granules occasionally

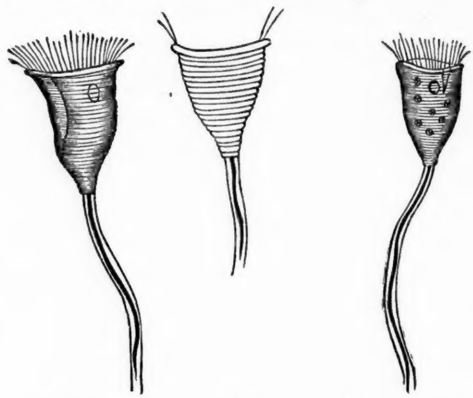

Fig. 3. Fig. 4. Fig. 5.

FIG. 3.—*Vorticella smaragdina*, sp. nov., showing lateral depression. × 180. FIG. 4.—Diagrammatic outline of *V. smaragdina* when extended. FIG. 5.—*Vorticella macrocaulis*, sp. nov. × 360.

roughen the surface and are barely visible under an amplification of 250 diameters, when they appear to add to the distinctness of the transverse striations without making themselves conspicuous. With magnification of 400 diameters they are seen to be minute, dark-bordered refractive particles arranged in no apparent order and having no connection with the surface striæ. They are not constantly present, and their absence seems to add to the beauty of this peculiarly attractive creature. When the infusorian is well and the surroundings are auspicious, but little of the contracted pedicel remains uncoiled, this atomie of living emerald then quivering at the summit of a crystalline spring, like a spherule of chrysoprase on a coil of silver thread.

The pencil can give hardly more of this exquisite creature's appearance than a diagrammatic outline, and little more has been attempted in the figures (Figs. 3 and 4). The translucent green coloration of the entire sarcode, the peculiar indentation of the side, the delicate poise of the contracted body at the summit of the closely coiled foot-stalk, the whole charm of the living creature is lost in the lines of black and white.

Vorticella smaragdina, sp. nov.—Extended body, conical-campanulate, changeable in shape, an irregular depression often formed on one lateral border; the width of the peristome nearly equal to the length of the body, the anterior margin dilated, somewhat constricted beneath the peristome border, the posterior body-half tapering to the pedicel; cuticular surface finely striate transversely and often roughened by minute, scattered granulations; peristome border everted, slightly revolute; ciliary disk very slightly elevated; the entire parenchyma translucent and colored emerald-green; vestibular bristle conspicuous; pedicel colorless, eight to ten times as long as the body, contracting in numerous close coils; contracted body subspherical, a posterior annulation sheathing the extremity of the pedicel. Length of body $\frac{1}{500}$ to $\frac{1}{300}$ inch. Habitat: Rootlets of Lemna in ponds in Western New York. Solitary or few together.

In external contour as well as in the length of the pedicel another species of the genus, which I have named *Vorticella macrocaulis*, resembles *V. longifilum* S. K. It is, however, immediately distinguished by its surface striations which, although fine, are distinct, and by the proportion borne by the length of the body to the width, the former, with *V. longifilum*, being twice the latter, while in the species under consideration these parts differ much less in relative size. No recorded member of the genus possesses a pedicel of so great a length as the one here referred to, except *V. longifilum* and *V. telescopica*, both of the latter having an unornamented cuticular surface. If this contractile foot-stalk were delineated under an amplification equal to that of the body in Fig. 5, it would necessarily be depicted from six to seven inches long, being ten to twelve times the length of the extended zoöid.

Vorticella macrocaulis, sp. nov.—Body elongate-campanulate, one and one-fourth times as long as wide, attenuate and tapering posteriorly; peristome somewhat wider than the greatest width of the body, everted and thickened but not revolute; ciliary disk evenly rounded and elevated; cuticular surface finely striated transversely; contracted body obovate; pedicel ten to twelve times as long as the extended body, its entire length contracting into close coils. Length of body $\frac{1}{600}$ inch. Habitat: Shallow ponds in Western New York, attached to Lemna rootlets. Solitary.

Still another species of Vorticella from the same habitat is that

shown in Fig. 6 under the name of *V. utriculus*, which resembles in form *V. striata* Duj., a salt-water infusorian. In its conspicuous surface striations it also suggests the marine animal, and in size, furthermore, the two somewhat closely correspond. In the comparative proportion of breadth and length they differ, also in width of peristome as well as in the length of their respective pedicels, that of the marine form being twice and that of the sweet-water species three times as long as the body. *V. utriculus* may be a fresh-water variety of *V. striata*. The coincidences of

Fig. 6.

Fig. 7.

FIG. 6.—*Vorticella utriculus*, sp. nov. × 437. FIG. 7.—*Vorticella macrophya*, sp. nov. × 535.

form and other essential characters are at least interesting and suggestive.

In its habitat it is disposed to be solitary, although it does not object to neighbors if not too near. Usually when one is found others are to be noted arranged singly on the same Lemna rootlet, and at almost equal distances apart. When contracted the pedicel is coiled in close rings, and has its distal end sheathed by the posterior termination of the body in a manner similar to that of *V. smaragdina* when in the same inactive state. It is shown extended in Fig. 6, magnified 437 diameters, and may be described thus :

Vorticella utriculus, sp. nov.—Body vase-shaped or subpyriform, somewhat changeable in shape, twice as long as broad, widest centrally, tapering posteriorly, and slightly constricted beneath the everted and revolute border of the peristome, whose width is a little less than the greatest breadth of the body; cuticular surface strongly and conspicuously striate transversely; ciliary disk slightly and obliquely elevated; vestibular bristle conspicuous; pedicel three times as long as the body; contracted zoöid obovate or pyriform. Length of body $\frac{1}{825}$ inch. Habitat: Attached to Lemna rootlets in ponds in Western New York. Solitary or scattered.

Descriptions of several members of one genus must necessarily contain much repetition wearisome to the general reader. The records can be scarcely more than comparisons of contour and structure, resemblances and dissimilarities. The habits of the numerous kinds of Vorticellæ are essentially the same. This particular one that I have named the "long-shaped" Vorticella, *V. macrophya*, bears a striking resemblance to *V. cucullus* From., and might justly be identified with that species, were it not for the presence of cuticular striæ and the absence of the cushion-like ciliary disk.

It is an interesting coincidence that this and two preceding forms from the same little pool, although they so widely differ, should so uniformly present, when contracted, the small annular sheath about the attachment of the pedicel. In every instance that portion of the zoöid which accompanies the distal end of the stem into the body remains included until the animal is otherwise almost completely expanded, when that part slips out quite suddenly and so completes the act of dilatation. The Vorticella is shown expanded in Fig. 7, magnified 535 diameters.

Vorticella macrophya, sp. nov.—Body elongate-conical or obconic, twice to two and one-half times as long as broad, widest at the anterior margin and thence tapering to the attenuate posterior extremity; peristome border revolute, not everted; cuticular surface finely striate transversely; ciliary disk slightly and obliquely elevated; nucleus band-like, short, curved and situated in the anterior body-half; pedicel once and one-half to twice as long as the body, the muscular thread stout; contracted zoöid obovate, the posterior extremity sheathing the distal end of the spirally coiled pedicel. Length of body $\frac{1}{667}$ inch. Habitat: Attached to rootlets of Lemna from shallow ponds near Olean, Western New York. Solitary.

Jutting outward from the edge of Luna island on the American side of Niagara falls, within twelve feet of the curving brink of "the cataract which here shoots down the precipice like an avalanche of foam," projects a rock submerged and washed by the almost rythmic flow of the reflex currents from that mighty flood. There tangled clusters of a deep green Alga clung by a single point of attachment. The ripples swept above and left

them anon streaming wildly as the waters sank below the stone, only to dash them upward again as the waves rushed back. Scarcely thinking to obtain any animal life clinging to a plant that rejoiced in such swirling turbulence, I gathered the weed while my friend adhered to the extremities of my coat as desperately as the Alga adhered to that limestone rock. The plant, as the Rev. Francis Wolle, of Bethlehem, Pa., tells me, is *Cladophora glomerata* Linn.; the undescribed form of Zoöthamnium, unexpectedly found in thrifty abundance on the lower branches, is *Zoöthamnium adamsi*, sp. nov., named for the Rev. J. E. Adams,

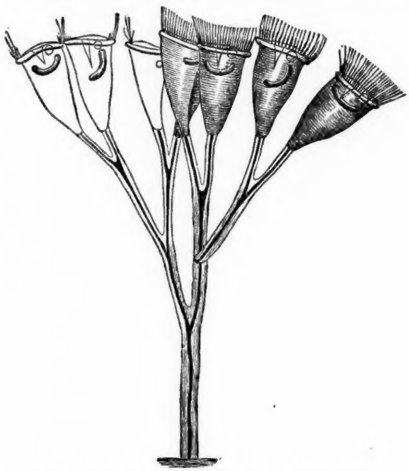

FIG. 8.—*Zoöthamnium adamsi*, sp. nov.

of Olean, N. Y., a cultured and eloquent gentleman, who assisted in its capture.

So far as external form is concerned the members of this colony resemble those of Saville Kent's *Z. simplex*, a company of elongated zoöids clustered at the summit of a smooth, unbranched stem. Both are conical, both are widest at the frontal border, both are tapering and attenuated toward the insertion of the pedicel, but here the resemblance ceases. The cuticular surface of the new form now referred to is not smooth, as is that of every other recorded fresh-water species, but is finely and delicately striated transversely. So closely approximated and so tenuous are these elevations that it is only after the most careful scrutiny under an amplification of not less than 400 diameters, that they

become apparent to a trained eye, and even then only as infinitesimal lines on the lateral borders of the extended bodies. No more careful adjustment of the objective, no more careful manipulation of the mirror is needed to study the markings of a diatom than is demanded by this little creature before its markings impress the observer's retina. In the figure (Fig. 8) they are represented by lines, fine it is true, but almost out of proportion to the elevations which Nature has placed on the living surface of the infusorial atomie, whose home was at the brink of that stupendous cataract of emerald and foam and spray-smoke, amid the eternal complaining of beaten rock and broken flood.

The supporting pedicel is usually simply bifurcated at a point distant from its algal attachment about twice as far as are the furcations of the branches from the extremity of the main rachis. Sometimes the pedicel throws off three branches from its summit, and more frequently four divisions. The prevailing form, however, is the dichotomous. Above the second series of bifurcations the branches become of diverse lengths, instances occurring in which the branchlet is twice as long as any other part. The length of the ultimate divisions, those immediately supporting the zoöids, seems quite constant, being usually about one-half as long as the extended body. The whole pedicel is stout and robust, and is conspicuously marked by longitudinal striæ. Its contractions are comparatively slow and few. There is none of that sudden coiling, as with the Vorticellæ, when the expanded infusorian leaps back into quick contractions and momentary quiescence that often startles the rapt observer.

After the colony has been under observation for a prolonged period an action takes place that I have not seen recorded with any member of the genus, a movement recalling the contractile performances of the disconnected muscular threads of individual members of Carchesium. Two neighboring zoöids fold together their ciliary apparatus, and their own private foot-stalks retract into coils without disturbing the general equanimity of the community. This has been observed repeatedly, the retracted muscular thread being, in every instance, in apparent connection with that of the remainder of the pedicel. This thread, however, seems to be delicate. For no visible reason it soon separates into numerous scattered fragments within the sheath. In those in-

stances just referred to, an inappreciable separation had probably taken place.

The contracted body, when certain adjuncts of the entire colony are taken into consideration, affords some points that may be of diagnostic value. The creature probably affects running water, or water agitated by proximity to a current, but that it is restricted to the restless waters beating the shores of Luna island and pouring a resistless flood to make that terrific plunge, is not to be thought of; there only was its original habitat so far as the writer is concerned; and when it is found, as it probably will be, in swift streams far beyond the sound of the "Thunderer of the Waters," its contracted form may offer some characters to aid in its identification. When the frontal region is folded together, and the whole body contracted, the zoöid bears some resemblance to the bodies, when in a similar condition, of *Opercularia plicatilis*, described by the writer in the *American Monthly Microscopical Journal* for December, 1884. The anterior snout-like projection, the radiating cuticular elevations, the posterior annulations, are all similar. With the Zoöthamnium, however, the conspicuously crenulated border of the projection and its longitudinal plications, of the Opercularia, are absent or obscure, while the radiating ridges on the shoulder of the Zoöthamnium are much more prominent though fewer, and the posterior annulations, though as numerous, are less marked.

The short, curved, band-shaped nucleus is constantly present in the anterior body-half, but its relative position is inconstant. At times its concavity is presented directly forward toward the ciliary disk, at others it is nearly perpendicular, with the convexity directed outwardly, and in rare instances it is transversely placed near the center of the body.

A colony of this attractive infusorian is delineated in Fig. 8. The cuticular markings, as before intimated, are chiefly shown to emphasize the fact of their existence, not to exhibit their tenuity or number.

Zoöthamnium adamsi, sp. nov.—Body elongate-conical or conical-campanulate, twice as long as broad, widest anteriorly. tapering to the pedicel, and slightly constricted beneath the peristome border; cuticular surface very finely striate transversely; peristome border wider than the body, revolute; ciliary disk rounded and elevated; contractile vesicle single, situated beneath the peristome border; nucleus short, band-like, curved and anteriorly placed; main rachis of the pedicel usually bifurcate, frequently quadrifid, occasionally tripartite; branches dichotomous, un-

equal in length, commonly shorter than the main stem, the ultimate divisions less than one-half the length of a single zoöid, each division supporting a single animalcule; entire pedicel stout, longitudinally striate; contracted zoöid obovate or subpyriform, the frontal border projecting in snout-like manner, and the anterior body-half thrown into prominent longitudinal plications, the posterior body-half into several annulations. Length of body $\frac{1}{417}$ (0.0024) inch; height of main stem $\frac{1}{334}$ (0.0030); of the entire colony $\frac{1}{112}$ (0.0090) inch. Habitat: Attached to *Cladophora glomerata* on the shore of Luna island in the rapid water of the Niagara river.

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NOTES ON THE PHYSICAL GEOGRAPHY OF THE AMAZONS VALLEY.

BY HERBERT H. SMITH.

MOST of our common maps indicate a triple division of the Amazons, the Peruvian portion being called Marañon, the Middle Amazons, Solimoens, while all below the junction of the Rio Negro is distinguished as the Lower Amazons. Geographers have treated this division as one of custom and convenience only, and so far as the Peruvian portion, or Marañon, is concerned, they are right; its distinction from the Solimoens is merely nominal, Brazilians and Peruvians speaking of both portions as the Upper Amazons. But this *Alto Amazonas* is constantly and clearly distinguished from the lower or main river. "The Amazons," say the river pilots, "is formed by the junction of the Solimoens and the Rio Negro; the Solimoens is called Upper Amazons because it is longer and has more important settlements on its banks, but it is really a branch like the Negro. Indeed, at the junction it is the Solimoens which forms an angle, while the Negro is directly in a line with the Lower Amazons, so that it appears to be the main river." This idea is universal among the river people, and it has led to many important results. The "Amazons" and "Solimoens" are well recognized in commercial affairs, and they have even formed the basis of a political division, the limits of the provinces of Pará and Alto Amazonas corresponding pretty nearly with those of the Lower and Upper Amazons.

The division is, in fact, much more significant than geographers have supposed. Whatever may have led to the distinction of names, there is a real and well-marked physical division, not only of the river itself, but of the country and its fauna and flora. Mr. Bates is, I believe, the only traveler who has clearly indicated

some of the differences between the two regions. Following him in part we may thus divide them:

1. The Upper Amazons region, to the base of the Andes and for hundreds of miles on both sides of the river, is a perfectly level expanse, nowhere raised more than a hundred and fifty feet above the river and generally only just out of reach of the highest floods. The Lower Amazons, on the contrary, passes through a comparatively high country, with table-lands several hundred feet above the river and many abrupt hills or even mountains. These elevations increase towards the north and south until they join the great table-lands of Guiana and Brazil.

2. As a consequence the great tributaries of the Upper Amazons—notably the Purús, Juruá and Içá—present a perfectly open navigation almost to their sources; but those of the Lower Amazons are obstructed by rapids and falls where the water flows down from the highlands. A secondary consequence is that the Upper Amazonian branches are very crooked, while those of the Lower Amazons are comparatively straight.

3. The soil of the Upper Amazons is either a rich ferruginous clay or vegetable mold which, according to Bates, often attains a thickness of twenty or thirty feet; stones are hardly ever met with. On the Lower Amazons the soil is nearly always sandy, and mold forms only in favored localities, such as swamps and river-banks.

4. On the Upper Amazons the trade-wind is never felt, and the air is always moist and warm; rains are very frequent, especially near the Andes, and the dry season is only marked by the comparative lightness of the daily showers. On the Lower Amazons the trade-winds blow freely during a great part of the year, and there is a well-marked dry season; in some districts the rains cease almost entirely for weeks together. Probably the average temperature is somewhat lower near the Atlantic than on the Upper Amazons.

5. The great forest of the Upper Amazons, so far as we know, is unbroken except by the rivers, and it has a width of a thousand miles or more from north to south. The forest belt of the Lower Amazons is hardly half so wide, and it is interrupted in many places by *campos* or open lands, either grassy or stony plains, without trees, or sandy tracks with a thin semi-forest growth like that of Central Brazil.

6. The alluvial flood-plains of the Upper Amazons are far more extensive than those of the lower river, probably attaining in some places a width of at least one hundred miles. They are covered everywhere with heavy forest which, during a large portion or the whole of the year are flooded, so that canoes can pass freely underneath the branches. On the Lower Amazons the alluvial belt varies in width from fifteen to forty miles, and it is occupied, in great part, by open meadows which are only flooded during the rainy season.

7. The fauna and flora of the Upper Amazons are exceedingly rich in genera and species, and they are almost entirely composed of forms which are fitted only for a forest life. On the Lower Amazons such forms are mingled with others which belong to the open lands, or which are not essentially sylvan; in general the species are less numerous than on the Upper Amazons, and many of them are distinct, but allied or "representative" forms. Those species which are common to the two regions are frequently larger and of more rapid growth on the Upper Amazons.

As may be supposed the two regions fade into each other, but something like a definite boundary between them is formed by the Rio Negro on the north and the Madeira on the south side of the Amazons. These, the former with its broad expanse of water, the latter with its immense flood-plain, are almost impassable barriers to the migration of species. They, together with the main river, divide the whole Amazons valley into four parts, each of which is characterized by a pretty large number of animals and plants. The other great tributaries may limit lesser groups of species, and the great flood-plain has a perfectly distinct assemblage of animals and plants which, in their turn, differ essentially on the Upper and Lower Amazons.

Let us now, for the moment, leave the Solimoens and confine our attention to the region east of the Rio Negro and Madeira. The valley of the Lower Amazons is limited on the north by the mountain range which separates British and Dutch Guiana from Brazil. Most of these mountains are table-topped, and they are clearly remains of a great elevated plain. The region, two or three hundred miles wide, which separates them from the Amazons, is very imperfectly known, but it appears to be almost entirely occupied by a less elevated plain, edges or spurs of which

are seen near the river in the table-topped hills of Almeyrim and Velha Pobre, each more than 1500 feet high. This plain may be regarded as a great terrace, abutting abruptly against the high peaks of the Guiana chain, and cut down as sharply near the Amazons to a second terrace which forms a low region between the table-topped hills and the river flood-plain. Sometimes an intermediate terrace may be distinguished, as at Monte Alegre and Prainha; outlying and much denuded portions of the upper terrace are seen in the rugged hills of Ereré and Tajury, west and north of Monte Alegre.

The southern side of the valley, from the Madeira eastward, seems to be everywhere a low table-land, which rises gradually or by terraces to the elevated plains of Central Brazil. Near the Amazons and its tributaries it is abruptly cut down, forming bluffs three or four hundred feet high. A line of these bluffs extends, with slight interruptions, from the Tocantins almost to the Madeira. Generally the bluffs form the southern edge of the Amazonian flood-plain, but in some places, as near Santarem, they are separated from it by strips of low land answering to the lower terrace on the northern side. The bluffs themselves may correspond to the intermediate terrace of Monte Alegre and Prainha.

Between these northern and southern terraces, crossing the country from W.S.W. to E.N.E., is a low, flat, perfectly level expanse, very irregular in outline and varying in width from fifteen to forty miles; at the Atlantic end only it spreads out like a funnel, occupying perhaps a hundred miles of coast. The yellow Amazons winds through this flood-plain, rarely touching the borders, now pouring through the narrow pass at Obidos, now expanded into sea-like reaches, again broken into two or three portions, separated by great islands. Everywhere the alluvial land is dotted with shallow lakes and seamed with channels—goodly rivers which hardly appear on the maps. Constant changes are taking place in this network; new islands and shallows are formed almost every year, and old ones are altered or washed away. I know of one island, three miles long, which disappeared completely in less than ten years; the river steamboats now pass directly over its site.

On the Lower Amazons the islands and river-borders of the flood-plain are called *varzeas*, though properly the term is applied

only to those portions which are above water during more than half the year; lower and perennially wet tracts are known as *ygapós*.[1] In contradistinction, all dry land which is out of reach of the annual floods is called *terre-firme*. Islands of high land (*ilhas de terra-firme*) are frequently seen in the midst of the *varzeas* and along the irregular borders of the flood-plain it often happens that the *varzea* and *terre-firme* are mingled in the most complicated manner; such places would be puzzling enough to the student were it not that the alluvial land can be at once distinguished by its vegetation. Frequently the *varzea* or *ygapó* forest is continuous with that of the *terre-firme*, but the trees are always of distinct species, and no experienced woodsman would think of confounding them.

On the southern side of the mouth of the Amazons, separating it from the Tocantins and Pará, is a great lozenge-shaped island called Marajó. At its south-western end it is separated from the mainland by a network of narrow channels connecting the Amazons with the Tocantins. The tides ebb and flow in these channels but the south-westerly current predominates, so that a portion of Amazonian water reaches the Tocantins. The channels are cut through a wide stretch of alluvial land which is directly continuous with the flood-plain of the Amazons. Marajó itself is almost entirely composed of or covered with alluvial deposits. The eastern and northern parts of the island are occupied by *varzea* meadows, while the southern and western portions are almost continuous swamps, noted for their rubber trees and for their deadly fevers. The whole island abounds in shallow lakes, and it is cut up by hundreds of small creeks and channels, the haunts of alligators and serpents. Only along the eastern and southern edges there are some narrow strips of *terre-firme*, true rocky land raised well above the highest floods. The first settlers took advantage of these little dry spots, building their houses on them and sheltering their cattle there when the meadows were overflowed. Breves and other villages owe their situations to these *torrões*.

From the highlands of Guiana a number of rivers flow down, with many rapids and falls, to the Amazons. None of these streams have been explored to their sources, and most of them are known only near their mouths, where they flow across the

[1] In Tupy, a wet land or swamp.

region which I have called a lower terrace. As soon as they enter this region the rapids cease, and immense flood-plains spread out on both sides. Besides the fact that these flood-plains are out of all proportion to the rivers, they are remarkable for the extreme irregularity of their borders. Every little stream which enters the main affluent passes through a flood-plain of its own, often five or six miles broad, though the stream itself may be hardly as many feet across. Crooked bays of *varzea* extend far into the mainland; numberless islands of *terre-firme* are scattered over the flood-plain; and the most conscientious map-maker who attempts to unravel this tangle is likely to give up in despair. The irregularity generally increases toward the Amazons, where the alluvial land of the tributaries spread out broadly until it is lost in the Amazon flood-plain.

Three great tributaries—the Tapajós, Xingú and Tocantins—flow down over the southern table-land from the center of South America. Geographically it should be said, the Tocantins cannot be regarded as a tributary of the Amazons; its mouth, called the Pará river, receives a portion of Amazonian water, but it opens into the Atlantic and is separated from the main mouth of the Amazons by Marajó. Physically the three rivers resemble each other closely. They are all clear-water streams, flowing down, with many rapids, to a point about 150 miles from their mouths, where the rapids cease, and the rivers gradually expand into quiet lakes. The lakes are bordered by bluffs, edges of the table-land and continuous with those which border the southern side of the Amazonian flood-plain. In their lower portion these lakes are from seven to ten miles wide and very deep; they have hardly any current, but rise and fall with the tides as regularly as the sea. At their northern ends they are suddenly contracted by the Amazonian flood-plain, and here they receive Amazonian water through narrow channels or *furos.* The *furos*, where they open into the lakes, are still bringing in Amazonian sediment, and they have thus pushed their mouths far into the clear water. The Tapajós and Xingú finally reach the Amazons through embouchures less than half a mile broad—about the average width of these rivers near their lower falls.

Some smaller rivers which enter the Amazons from the south have more or less muddy waters, and these have filled up their valleys with sediment. The flood-plains thus formed are bordered

by bluffs precisely like those along the Lower Tapajós and Xingú. It is evident, then, that these muddy rivers, in their lower courses, were once expanded into lake-like reaches, similar to those of the clear-water tributaries.

If we now return to the northern side of the Amazons we shall find at least one clear-water tributary, the Trombetas, which is lake-like along its lower courses. But as the river here passes through low *terre-firme*, the bluffs are wanting; the borders are extremely irregular, and numerous small lakes open into the main one on either side; islands or peninsulas of low, rocky land separate these lakes from the river, and smaller islands are cut off in the lakes or in the river itself.[1] In fact the whole corresponds precisely to the irregular flood-plains of the other northern tributaries. The latter, being muddy, have filled up the lakes and channels with sediment, and they now wind about in broad alluvial tracts, the borders of which seem to be inextricably mingled with the *terre-firme.*

I believe it can be shown that all the main tributaries of the Lower Amazons are, or have been, lake-like in their lower courses. The question then arises: Were these lakes produced by a damming back of the tributaries by Amazonian silt, so that they filled up their valleys? I think not. No doubt the alluvial land, closing the mouths of the lakes, has tended to raise their waters; but the flood-plain of the Lower Amazons is everywhere so near the level of the sea that this uplift cannot have been very great. The tides, which are felt on the main Amazons as far as Obidos, are very apparent on the Lower Xingú and Tapajós; Bates noticed them on a secondary tributary of the latter river nearly six hundred miles from the ocean. It is well, also, to note the similarity of the Tapajós and Xingú to the Tocantins, which opens broadly into the sea and cannot owe its lake-like lower course to any damming back of the waters.

Having reached this point it requires but little imagination to apply the same reasoning to the Amazons itself; to look upon the flood-plains as a filled-up sea or great bay, with many branches, which now form the flood-plains or tidal-lakes of the tributaries. Let us go back in imagination to the period before this sea was filled up and map out the Amazonian system as it then was.

Stretching eight hundred miles west-south-westward from the

[1] I owe these notes on the topography of the Trombetas to Professor O. A. Derby.

Atlantic, a narrow estuary bay or inland sea divided the northern part of the South American continent. The water in the eastern portion was clear and salt; heavy tides swept up the long sand-beaches and dashed against the cliffs of clay and conglomerate. In general the channel was clear, but here and there little rocky islands added to the picturesque beauty of the shores. On the northern side a number of blue mountains could be seen; spurs and outlyers of the table-land which stretched down from the Guiana chain. To the south a line of bluffs fronted the water, the northern edge of another great table-land. The Tapajós, Xingú, Trombetas and many smaller rivers flowed into the Amazonian sea through long branch estuaries or tidal bays. Some of these streams were muddy and tended to fill up their mouths; others preserved clear, deep channels.

Just at its mouth, on the southern side, the great estuary met a lesser one, now the Lower Tocantins, and its outlet, the Pará. The two bays were partly separated by a string of low sandy islands and reefs, like those now fronting the sounds along the south-eastern coast of the United States. These reefs now form the *torrões* along the southern and eastern side of Marajó.

In the Amazonian bay the greatest extent of brackish or fresh water was towards the western end, where the water was shallow and much obstructed by islands. Islands and shallows owed their existence to, and were yearly being built up by, the Solimoens and Madeira, which here poured in their floods of muddy water. The mouths of these rivers formed two branches at the head of the bay; a third branch marked the outlet of the Negro, which, as it brought down little sediment, preserved a wide and clean channel.

Then, as now, the trade-wind blew in freely from the Atlantic, and the climate was equable and moist. The plants and animals of the shores were probably similar to those which now inhabit the highland, but the great estuary formed an impassable barrier to many species, and the Guiana fauna and flora were more sharply divided from those of Brazil. The estuary itself was inhabited principally by marine forms of fishes, Crustacea and Mollusca; only at the western end, where the larger rivers emptied in, brackish-water forms prevailed.

Gradually the alluvial land at the head of the bay extended eastward, filling up the estuary with islands. As this eastward

movement went on, the branch estuaries were blocked up at their mouths by the islands which formed in front of them. Where the branch received a muddy tributary it also was filled up; but the clear-water tributaries, like the Tapajós, Xingú and Tombetas, brought down no sediment, and their estuaries, closed at the mouths, assumed the form of lakes.

In this way the whole of the Amazonian flood-plain has been built up. Passing now a step farther back it is easy to see that the flood-plains of the Solimoens and Madeira were formed in the same way. But the vast extent of this alluvial land on the Upper Amazons seems to indicate a widening of the great bay at its upper end; a kind of inland sea connected with the ocean towards the east by a comparatively narrow strait.[1] This sea, at the period of which I am speaking, had no connection with the Orinoco valley, for the Amazonian flood-plain is now separated from that river by rocky *terre-firme*, indicated by the falls of the Orinoco and Negro. Several large rivers, flowing down from the Andes, emptied into the sea near its western end, and eventually transformed it into a river by filling its bed with sediment. These Andean torrents still exist as the Huallaga, Ucayale, Napo, Tigre and extreme Upper Amazons.

Such a branched estuary bay as I have described could only have been formed by the subsidence of land over a great area, and the encroachment of the sea on the valleys of some former Amazons and its tributaries. This subsidence must have taken place subsequently to the deposition of the clays and sandstones which form much of the *terre-firme* along the Lower Amazons. For the very tributaries on which the above arguments have been based flow through valleys which they have cut in the clays and sandstones themselves. It appears probable, also, that the period of subsidence was anterior to the formation of the *Tabatinga* clays on the Upper Amazons.

For the sake of clearness I have described the silting-up of the valley as occurring during a period of repose subsequent to the subsidence. But it is quite possible that the subsidence and filling up were, in part, contemporaneous. The Upper Amazonian sea may have had its outlet through a Lower Amazonian river

[1]It may be, however, that this widened flood-plain is due to the extreme shallowness of the valley of the upper river; the Amazons, dammed back somewhat by the accumulations below, would tend to spread out on either side and build up its own bed.

which, by the sinking of the land, was changed to an estuary while the sea was being filled with sediment. These questions must be settled by a more careful study of the Upper Amazons and its tributaries and especially of the Madeira and Negro. But whatever the changes may have been it is certain that the Amazonian river system is much older than the period of subsidence of which I have spoken. The slow pulsations of the earth have sent many throbs to this equatorial region; centuries of subsidence have been followed by centuries of upheaval, and these again by depression; river has become sea and sea has passed into river and estuary again and again since first the rains and springs united to form an infant Amazons. We have some glimpses of this older history, but as yet geological exploration on the Amazons is too new to give us any very clear sequence of events.

It appears certain that the immense low plain of the Upper Amazons was occupied by a Tertiary sea, older and much larger than the one which has been described above. Tertiary marine shells have been found at several points on the Marañon and Solimoens, and the *Tabatinga* clays which contain these shells extend far up the Japurá and Purús. The upheaval which placed these clays beyond reach of the river waters may have taken place long previous to the estuary depression, and many changes may have intervened. It appears probable that this Tertiary sea opened into the Atlantic through what is now the valley of the Orinoco, and that the Cassiquiare, which at present unites the two great river-systems, may correspond to one side of the strait or channel. It has been supposed that the sea had two outlets, one by the Orinoco valley and the other by that of the Lower Amazons, and that the Guiana highland formed a great island between them. Of this I think there is no sufficient proof. On the Lower Amazons the bluffs between the Tapajós and Tocantins and the table-topped hills of the northern side are formed of clays and ferruginous sandstones; but it is yet to be shown that these are continuous with the Tertiary formations of Tabatinga. Similar clays and sandstones occur all through Central and Eastern Brazil and in the Argentine Republic, but they belong to many different ages; no one who has studied geology in Brazil will be likely, on mere lithological grounds, to unite formations a thousand miles apart. The clays of the Lower Amazons, then,

may be older or newer than those of the Marañon, and the Tertiary sea which left the shells at Pebas may or may not have been united with the ocean by a Lower Amazonian strait. Some facts in geographical distribution lead me to suppose that Guiana was then united to Central and Southern Brazil. In that case the Amazons may possibly have flowed westward into the Tertiary sea from some high land farther east.

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HIBERNATION OF THE LOWER VERTEBRATES.[1]

BY AMOS W. BUTLER.

IN a recent article in *Science* (Vol. IV, No. 75, pp. 36–39) Dr. C. C. Abbott gave the results of his observations of the hibernation of some of the lower vertebrates.

I have for several years, as opportunity offered, noted my observations in this line, and while my experience in some respects has been similar to that of Dr. Abbott, I feel that the results I have obtained may be appreciated by others similarly interested.

The climate of New Jersey and Southern Indiana is much the same; this fact will lead us to expect somewhat similar results from our observations.

The common box tortoise, called also "land tortoise" and "terrapin," according to locality, hibernates regularly in Southern Indiana. It frequents the drier woodland, partially overgrown with underbrush. It enters the ground in the latter part of September or early in October to a depth not exceeding a foot, the average being from eight to ten inches.

A few years ago, in March, I was burning over a track of woodland on which were a number of brush piles; when the fire burned out I passed by where some of the brush piles had been and noticed that the ground appeared to have been torn up as though a charge from a shot gun had been fired into it. Examination, in several instances, revealed the fact that the work had been done by tortoises. The heat having penetrated to the depth of their winter quarters and aroused them from their winter's sleep, they now sought the surface and the cause of their sudden awakening.

The day being quite cool I placed them in a beaten road which

[1] Read before Section of Biology A. A. A. S., at Philadelphia meeting, 1884.

passed through the woods and awaited further proceedings; they appeared to realize that they had entered upon their summer career too soon, and a few moments saw them all safely buried beneath neighboring brush piles and bunches of leaves.

The box tortoise emerges from its winter quarters late in April or early in May.

Mud turtles, including all the river and pond turtles, hibernate in this locality, but there will, no doubt, be occasional exceptions found to this rule.

The "soft-shelled" turtles burrow deep into the mud, while their "hard-shelled" relatives are not so susceptible to climatic changes, and their wintering places are not at such a depth.

I have under my charge a water-power canal fourteen miles long, parts of which are thickly populated by turtles. In the winter time while making repairs, "hard-shelled" turtles are often found at a depth of four to twelve inches beneath the earth in the bed of the canal; when one is found we feel quite confident of finding from two to four companions near by. Many turtles frequent little coves along the banks of the canal, where the water is from two to three feet deep; these indentures are generally made by muskrats; in repairing the destruction they cause as many as three or four "hard shells" are sometimes taken from their muddy quarters.

The White-Water rivers are very clear in winter, enabling one to examine even their deeper portions to advantage. I have never been able to hear of an instance where a turtle has been seen even in the deepest water; besides, the deeper pools are seined almost every winter, and I have been unable to learn of a turtle ever having been drawn out in a seine at that time of the year.

My fellow-worker, Mr. E. R. Quick, gives me some notes which are exceptions to the rule of hibernation just mentioned. He says: "I have known mud turtles (*Aromochelys odoratus* Latreille) to leave ponds which became dry in the winter time and go to the river near by. In the winter of 1874–5 I saw the tracks of a large turtle in the snow leading from the bed of a pond which had become dry, to the river a short distance away. I think the tracks were made while the snow was melting."

The above instances appear to indicate that the act of hibernation is voluntary to a certain extent. I have found "hard-shelled" turtles that had been left at some distance from the river by win-

ter floods; they appeared dead, but when brought to a fire became quite active. "Soft-shell" turtles always die when thus thrown out by rises in the river in winter.

Our more tender fish hibernate, but there are many hardy species that frequent the deeper pools of our rivers and are caught in large numbers by means of seines and nets let down through the ice.

The species most commonly caught in this manner are quill-backs (*Carpoides velifer* Rafinesque, and *C. cutisanserinus* Cope), white sucker (*Catostomus teres* LeS.) and the "hog sucker" or "molly-hog" (*C. nigricans* LeS.). The latter is apparently the hardiest of our fishes, being found in winter in shallow water of from six to twelve inches in depth. When the ice is three or four inches thick and clear, many "molly hogs" are caught in the following manner: The fisherman walks slowly along the edge of the river on the ice, keeping a close lookout for fish, which will be seen just beneath the ice; a heavy blow with an axe immediately above where they are either kills or stuns them; hastily cutting a hole in the ice the fisherman throws his fish out and proceeds in search of another. By this method, some winters, great quantities of fish are caught.

The common toad regularly hibernates, in sandy soil burrowing to the depth of eighteen inches, in clayey ground the average depth attained is about eight inches. They frequent gardens and are often found in their burrows in autumn by the gardener when burying garden produce and apples. In early spring they are frequently thrown out by the spade during early gardening, and in a few moments hop off apparently without impediment.

Frogs are, at times, found some distance from water, passing the winters burrowing in damp places.

Early last spring when clearing out a cellar window two leopard frogs (*Rana halecina* Kalm) were found burrowed beneath the accumulation of the past year. The weather was quite cool and the frogs appeared to be dead, but when taken into a warm room they soon revived and began croaking. The locality where these frogs were found is on a ridge about seventy-five feet high and over three hundred yards from the river.

As a rule newts and salamanders do not enter the ground but spend the winter in springs and beneath leaves and logs in the damper woods. I have found them in winter, when the springs

were not frozen, to be quite active. I have taken the common newt on several occasions in damp woods, under logs, when they appear to be frozen, but when placed in the sun or held in the hand a short time would revive. Early in March the woodland ponds ot this vicinity teem with salamanders of different species.

In this part of the Ohio valley, as a rule, tortoises, turtles, toads and frogs are found hibernating; on the other hand the newts, salamanders and many species of fish do not enter a torpid state.

Exceptions to these rules will doubtless occasionally be noticed, but from the present state of our knowledge of the life-histories of these animals they hold good.

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THE AMBLYPODA.

BY E. D. COPE.

(Continued from page 1202, Vol. xviii.)

Dinocerata.

In this suborder we have a series of mammals which are in some respects the most remarkable that have ever existed. This is true whether we regard the bizarre appearance of their skulls, their dentition, so weak when compared with the bulk of their bodies, or the insignificant size of their brain. We only know them as yet from the Bridger or Upper Eocene formation of North America, with a species possibly from the Wasatch or Lower Eocene.

The characters of this suborder have been already pointed out (Vol. XVIII, p. 1121). The differences from the Pantodonta are well marked, but the resemblances are such as to render it impossible to refer the Dinocerata to a different order. Their strong resemblances to the Proboscidia are generally admitted, but the few characters which distinguish them are of the first importance. These are, first, the very small size of the brain, especially of the cerebral hemispheres; and second, the double distal articulation of the astragalus, where the facet for the cuboid bone is nearly as large as that for the navicular.

Within the above definition there is room for much variation, which, however, the known genera do not display. They agree in various points of minor importance. Thus there is no sagittal

crest of the skull, the temporal ridges being lateral, and there is a great transverse supraoccipital crest. These crests are more or less furnished with osseous processes or horns. The middle pair of these (Fig. 29) consists in part of the maxillary bone, and stands in front of or over the eye. The nostrils are well roofed

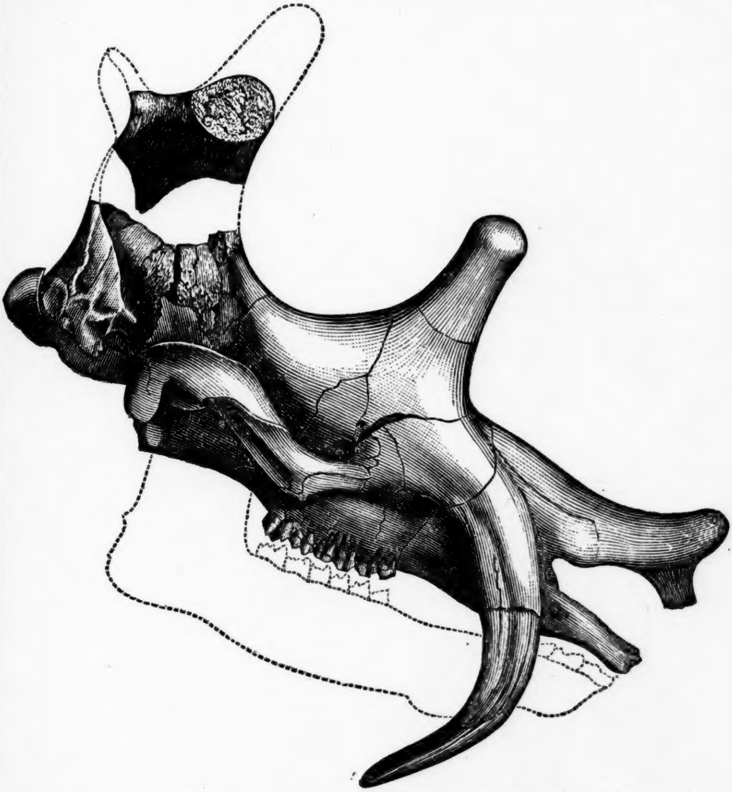


FIG. 24.—*Loxolophodon cornutus* Cope, skull from right side, one-eighth natural size. From the Bridger bed of Wyoming. Original, from Report U. S. Geol. Survey Terrs., F. V. Hayden, Vol. III. Lower jaw restored from Osborn, Memoir on Loxolophodon and Uintatherium. From individual represented in Pl. I.

over by the nasal bones. There is always a diastema behind the canine tooth in both jaws. There is less difference between the premolar and molar teeth in the known genera than in the Pantodonta, and they all have the same pattern, although the origin of the pattern may be different in the two series. Thus in the upper

jaw the crowns of the molars support two oblique cross-crests, which unite to form a V with the apex inwards. There is sometimes an internal cusp or tubercle. The inferior molars consist essentially of an outer V and a heel; the true molars differ in having the heel a little larger and more recurved on its posterior border, but it does not rise into a transverse crest as in the Coryphodontidæ. Mr. Osborn shows that the inferior incisors in Loxolophodon are compressed and two-lobed.

The known genera agree with the typical Proboscidia in the shape of the scapula with posterior expansion and apical acumination; in the flat carpal bones; in the absence of pit for round ligament of the femur; in the flattened great trochanter, contracted condyles, and fissure-like intercondylar fossa of the same bone. Also in the short calcaneum or heel bone, which is wider than long, and rough on the inferior face; in the five digits on both feet, and the wide peduncle and iliac plates of the pelvis and lack of angular production of the latter beyond the sacrum.

FIG. 25.—*Uintatherium mirabile* Marsh, bones of feet, two-ninths natural size. Upper figure anterior, lower figure posterior feet. From Bridger beds of Wyoming. Slightly altered (lunar bone) from Marsh, *Am. Journ. Sci. Arts*, XI, Pl. VI.

In spite of these resemblances, the Dinocerata are at one side of the line of descent of the mastodons and elephants (see Vol. XVIII, p. 1121, for phylogeny of the hoofed Mammalia). This is indicated not only by the structure of their feet, but by that of their teeth, which, as I have shown, constitute a survival of the tritubercular type which had been left behind by all other cotemporary ungulates, and only survived in the flesh-eaters of the Bridger epoch.

The resemblance of the feet to those of Coryphodon may be readily seen by comparing Fig. 25 with Figs. 1–2 (p. 1110, Vol. XVIII). The characters of the component parts are quite identical.

Professor Marsh has given us a figure of the cast of the brain chamber of the *Uintatherium mirabile* Marsh. It displays most striking peculiarities. These are: (1) The small size of the hemispheres; (2) the difficulty of distinguishing the cerebellum from the surrounding parts; (3) the large size of the olfactory lobes (Fig. 26). In all these respects there is a great resemblance to the brain of Coryphodon (Fig. 13). The hemispheres pass into the olfactory lobes by a gradual contraction of their outlines. They rise higher than, and then descend posteriorly towards the mesencephalon and cerebellum. The latter parts, as in Coryphodon, are not distinguished in the cast. The hemispheres are not convoluted, nor is there any sylvian fissure, according to Marsh's figures. This brain, as remarked by Marsh, is the most reptilian among the Mammalia. One of the strongest confirmations of this statement, is the small size of the cerebellum.

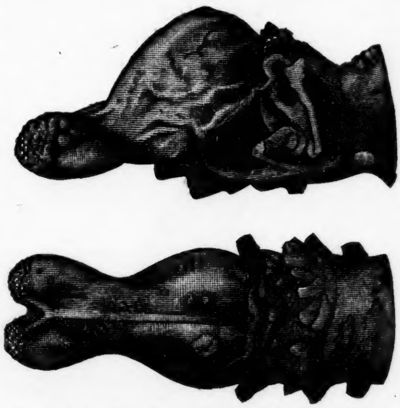


FIG. 26.—*Uintatherium mirabile* Marsh, brain' one-third nat. size. From Marsh, *Amer. Jour. Sci. Arts*, Vol. XI, Pl. IV.

Owing to the imperfect character of the material which I have had the opportunity of examining, it is not possible to state the number of genera with absolute certainty. There are certainly three of these, and probably four. So far as present knowledge goes, they pertain to one family, which I have called the Eobasiliidæ. The three genera mentioned differ in the forms of the mandible; the fourth has certain cervical vertebræ of a peculiar form, but the form of the mandible is unknown. I can only contrast the genera as follows:

A. Mandible unknown.

Certain cervical vertebræ short and flat, as in Proboscidia .... *Eobasileus.*

AA. Symphysis of mandible with four teeth on each side.

a. Mandible without inferior expansion.

Cervical vertebræ not very short; three premolars; lower incisors bilobate, *Loxolophodon.*

aa. Mandible with anterior inferior expansion.

Cervical vertebræ not short; three premolars..................... *Octotomus.*

aaa. Mandible expanded below, its entire length.

Cervical vertebræ unknown; four lower premolars; four incisors, simple, *Bathyopsis.*

AAA. Symphysis of mandible with three or two teeth on each side.

Mandible with very narrow symphysis........................ *Uintatherium.*

In probably a majority of the species the lower jaw has a deep flange on its inferior border below the canine teeth, which serves, like the corresponding structure in the saber-tooth tigers, to pro-

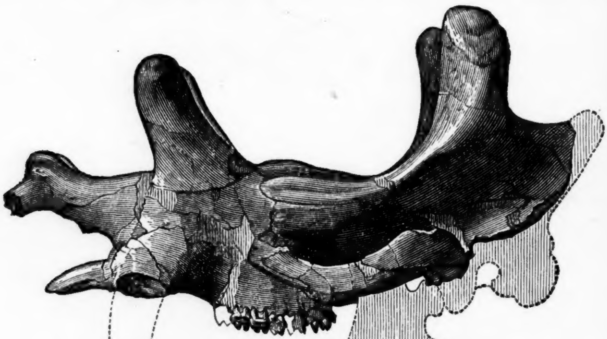


FIG. 27.—*Uintatherium leidianum* Osborn, skull left side, one-eighth nat. size; rom the Bridger beds of Wyoming. From Osborn, Memoir on Loxolophodon and Uintatherium.

tect the long superior canine tooth from lateral blows and strains (Fig. 27). In Bathyopsis this inferior expansion includes almost the entire inferior border of the ramus, giving an outline something like that of Megatherium (Fig. 35).

The genus Eobasileus was established on a species (*E. pressicornis* Cope) which is represented by a considerable part of the

skeleton, but without cranium or teeth; hence most of its characters remain unknown. The very short cervical vertebra which belongs to it serves to distinguish it from other genera. A second specimen (*E. furcatus*) found near the first, may belong to it; it includes a fragmentary cranium, but unfortunately no cervical vertebræ. Its introduction into this genus is therefore purely arbitrary.

The typical species is of large proportions, only second in size to the *Loxolophodon cornutus.* Its limbs were more slender in their proportions. It is in this species that I find much evidence in favor of the presence of a proboscis of greater or less length. Should several of the other cervical vertebræ have been as short as the one preserved, it is evident that the animal could not possibly have reached the ground with a muzzle so elevated as the long legs clearly indicate. In the species of the other genera, where the cervical vertebræ are longer, this may have not been the case.

The bones of this species were discovered by the writer in an amphitheater of the bad lands of the Washakie basin, known as the Mammoth buttes, in Southwestern Wyoming. They were in greater or less part exposed, lying on a table-like mass of soft Eocene sandstone. A description of this remarkable locality is given in the *Penn Monthly Magazine* for August, 1872.

The *Eobasileus furcatus* is principally represented by a skull in which the most important features have been preserved. As in all the species of Uintatherium in which the horns are known, these appendages stood in front of the orbits, it is probable that such was the case in the *Eobasileus furcatus* also. The muzzle is materially shorter and more contracted, and the true apex of the muzzle was not overhung by the great cornices seen in *Loxolophodon cornutus.* The occipital and parietal crests are much more extended in this species than in the *L. cornutus*, so that in life the snout and muzzle had not such a preponderance of proportion as in that species. All the species of this genus were rather rhinocerotic in the proportions of the head, although the horns and tusks produced a different physiognomy.

The known species of Loxolophodon Cope, are the largest of the order. Three species are known to be distinct: the *L. cornutus* Cope, *L. galeatus* Cope, and *L. spierianus* Osborn. They differ in the form of the horns and in the shape of the occiput.

The cranium in this genus is elongated and compressed. The muzzle is posteriorly roof-shaped, but is anteriorly concave and flattened out into a bilobed protuberance which rises above the extremity of the nasal bone. This extremity is subconic and short and decurved. A second pair of horn-cores stands above the orbits, each one composed externally of the maxillary bone, and internally of an upward extension of the posterior part of the nasal. Behind this horn the superior margin of the temporal fossa sinks, but rises again at its posterior portion, ascending above the level of the middle of the parietal bones. The occipital rises in a wall upwards from the foramen-magnum and supports, a little in front of the junction with the superior and posterior crests bounding the temporal fossa, a third horn-core on each side.

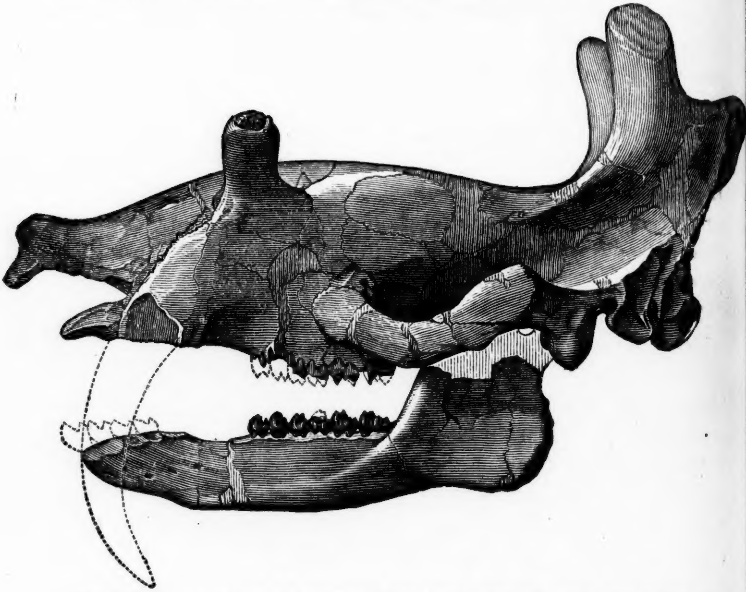


FIG. 28.—*Loxolophodon spierianus* Osborn, skull from left side, one-eighth natural size; from the Bridger beds of Wyoming. From Osborn, Memoir or Loxolophodon, etc.

The three species may be distinguished as follows:

Median horns triangular in section, with internal tuberosity, and above orbits; occiput narrow...*L. cornutus.*
Median horns subquadrate in section without internal tuberosity; occiput and nasal tubercles wide...*L. galeatus.*
Median horns subround and without tuberosity, in front or orbits; occiput and nasal tubercles narrow...*L. spierianus.*

The *Loxolophodon spierianus* Osborn, was as large an animal as the two others, and had a very elongate skull with weak horns and narrow, high occiput. Its median horns are situated well anterior to the orbit, and its zygomatic fossa is remarkably small. It was discovered by the Princeton scientific exploring party at the same locality that produced the other species, viz., the Mammoth buttes of Southwestern Wyoming (Fig. 28).

In the *L. cornutus* and *L. galeatus* the tuberosities which stand

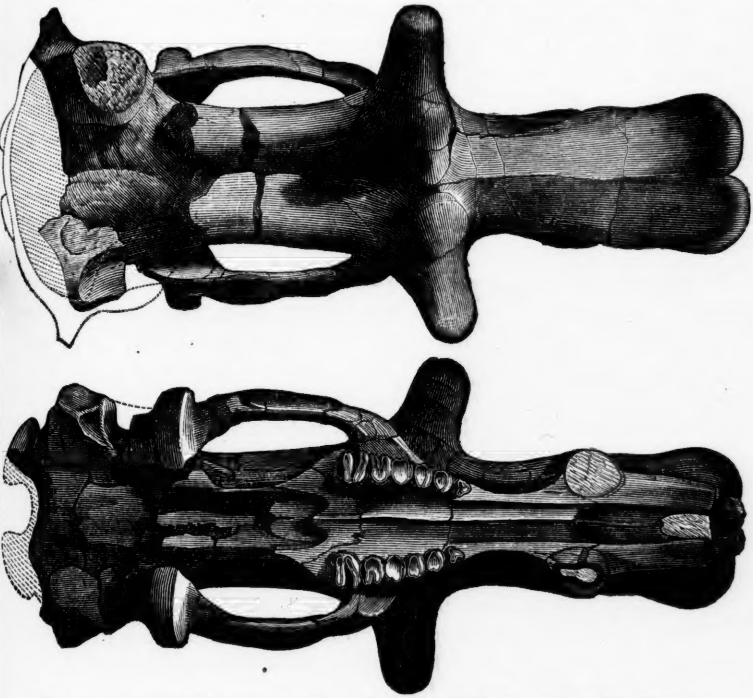


FIG. 29.—*Loxolophodon cornutus* Cope, skull of individual represented in Plate I, one-eighth nat. size. Upper figure superior surface; lower figure inferior surface. From Bridger Eocene of Wyoming. Original, from Report U. S. Geol. Survey of Terrs., F. V. Hayden in charge, Vol. III. Owing to distortion of the specimen behind, the occipital condyles are too far apart in the figure.

near the free extremity of the nasal bones are greatly developed, so as to represent a pair of cornices projecting upwards and forwards over the narrow apex of the bones (Fig. 24). From above, the end of the muzzle in those species has a bilobate outline. They differ from each other materially in the form of the middle pair of horns.

Mr. Osborn, of Princeton, has published a description of the lower jaw and teeth of a species of Loxolophodon, which he identifies with the *L. cornutus*, which was derived from the locality and horizon of the species above mentioned (Fig. 8). They show that the descending flange of Uintatherium and Bathyopsis is only represented by a convex ridge on each side of the symphysis. They point out the characters of the dentition, which are remarkable. The molars much resemble those of Bathyopsis. The canines and incisors are alike in form, and in a continuous series. The crowns are compressed so as to be extended anteroposteriorly, and are deeply emarginate, so as to be bilobed, the lobes with subacute edges. This form of incisors is unique, resembling only remotely the large median incisors of certain Insectivora (Fig. 30). Resemblance to mammals of the same type may be traced in the molar teeth.

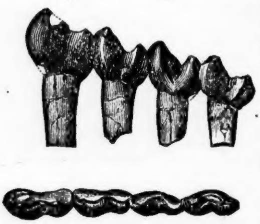
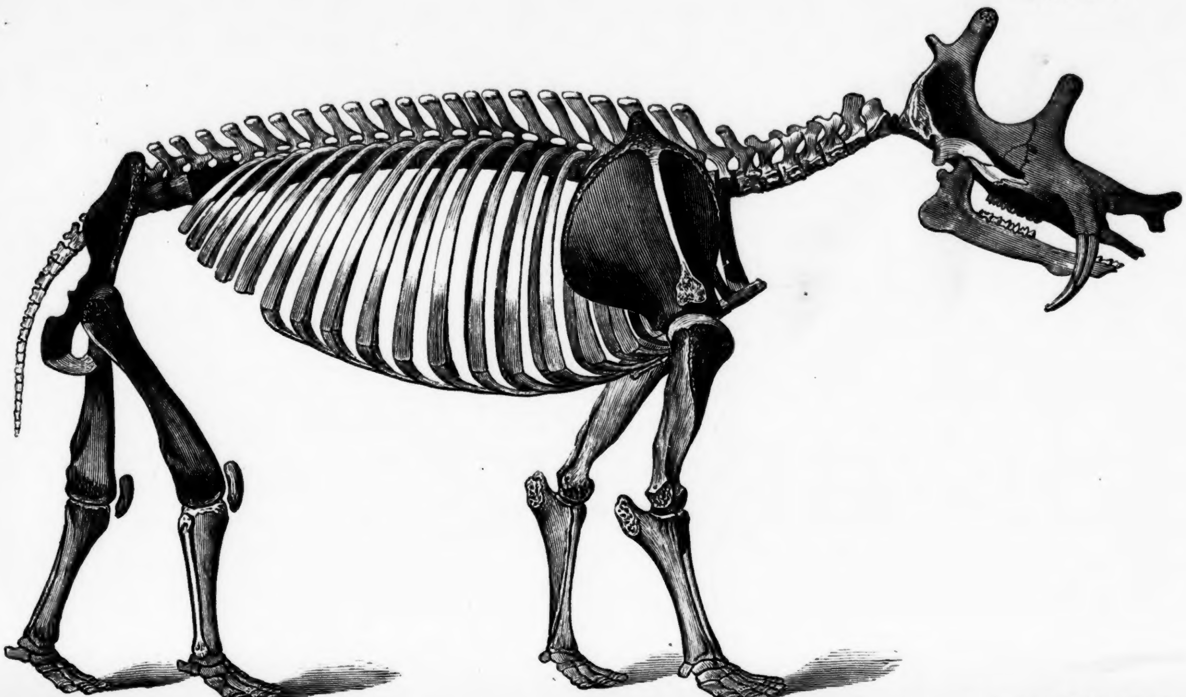


FIG. 30.—Incisor and canine teeth of left side of lower jaw of Loxolophodon, one-fourth natural size. From Osborn.

We may ascribe to the *Loxolophodon cornutus* form and proportions of body similar to those of the elephant (see Plate 1). The limbs, however, were somewhat shorter, as the femur (Fig. 31) is stouter for its length than in the *E. indicus*. It was intermediate in this respect between the latter species and the species of Rhinoceros. The tibia is relatively still shorter. The tail was quite small. The neck was a little longer than in the elephants, but much less than in the rhinoceroses; the occipital crest gave attachments to the *ligamentum nuchæ* and muscles of the neck, which must needs have been powerful to support the long muzzle with its osseous prominences, and to handle with effect the terrible laniary tusks. The head must have been supported somewhat obliquely downward, presenting the horns somewhat forward as well as upward. The third or posterior pair of horns towered above the middle ones, extending vertically with a divergence when the head was at rest. The posterior and middle pair of horns were no doubt covered by integument in some shape, but whether dermal or corneous is uncertain. Their penetrating foramina are smaller than in the Bovidæ. The cores have remotely the form of those of the *Antilocapra americana*, whence I suspect that the horns had an inner process or angle as in the

PLATE I.



Loxolophodon cornutus Cope, restored to $\frac{1}{27}$ nat. size. The darkly shaded portions are those in my possession; the feet and caudal and cervical vertebræ are restored after Marsh (Uintatherium); the lower jaw after Osborn. Original, from AMERICAN NATURALIST, 1882, p. 1029.

prong-horn at present inhabiting the same region. The nasal shovels may have supported a pair of flat divergent dermal tuberosities, but this is uncertain; they are not very rugose.

The elevation of the animal at the rump was about six feet, distributed as follows, allowance being made for the obliquity of the foot:

	Inches.
Foot	4.50
Tibia	20.50
Femur	31.75
Pelvis	16.00
	72.75

The anterior limbs were stouter than the posterior, judging

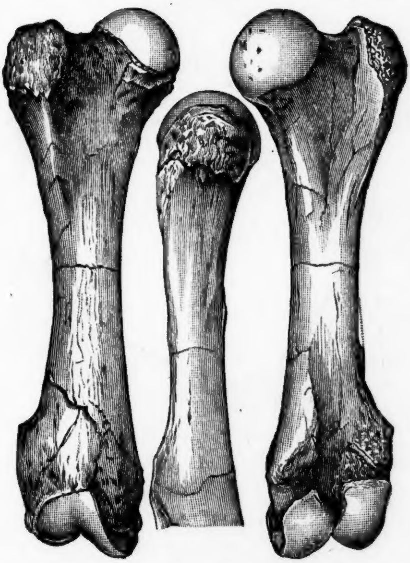


FIG. 31.—*Loxolophodon cornutus* Cope, femur of individuel represented in Pl. I, one-ninth nat. size. From Bridger beds of Wyoming. Original, from Report U. S. Geol. Surv. Terrs., III, F. V. Hayden in charge.

from the proportions in various species, and were no doubt longer if of the Proboscidian character. This would give us the hypothetical elevation at the withers:

	Inches.
Leg	61.00
Scapula (actual)	21.00
Neural spines (extremities)	7.00
Or 7 feet 5 inches	89.00

These measurements are made from the plantar and palmar surfaces, allowance being made for the pads.

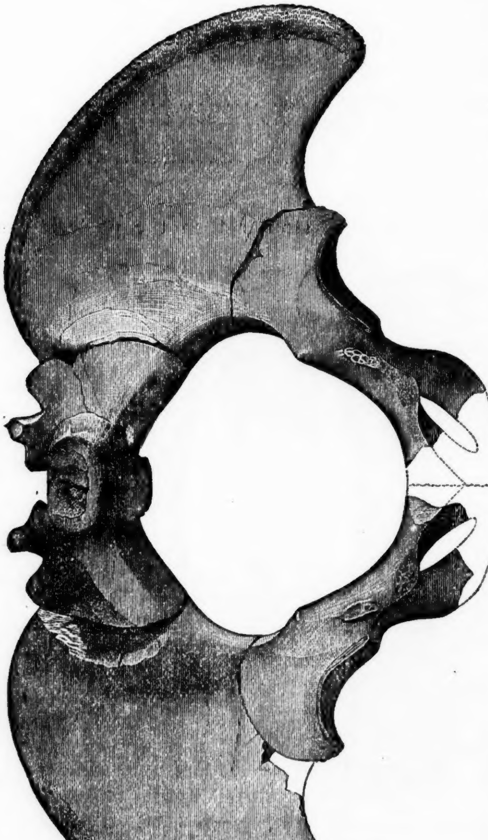


Fig. 32.—*Loxolophodon cornutus* Cope, pelvis of individual represented in Pl. I; from front; one-eighth nat. size. Original.

The obliquity of the anteroposterior axis of the anterior dorsal vertebra indicates that the head was posteriorly elevated above the axis of the dorsal vertebræ. Owing to the lack of cervical ver-

tebræ, the length of the neck cannot be determined. It may have been short, as in the *Eobasileus pressicornis*, or longer, as in the species of Uintatherium. The indications derived from the bones of the muzzle point to the attachment of a heavy upper lip. The numerous rugosities of the posttympanic and mastoid regions indicate the insertions of strong muscles. Some of these may have been adductors of large external ears.

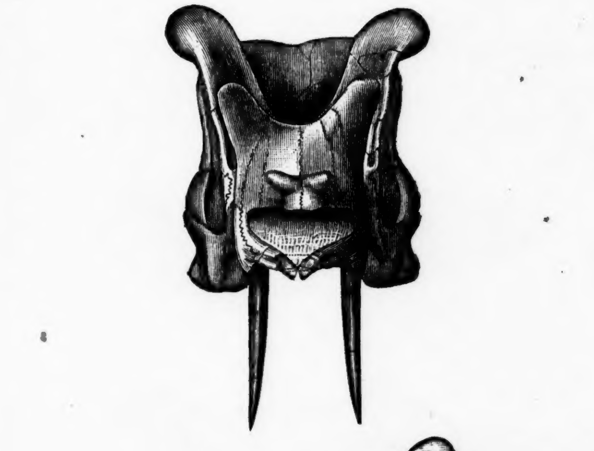


FIG. 33.—*Uintatherium mirabile* Marsh, skull, one-eighth nat. size; upper figure from front, lower figure from above. From Bridger Eocene of Wyoming. From Marsh, *Amer. Jour. Sci. Arts*, XI, Pl. II.

The inferior incisor teeth have no adaptation for cutting off vegetation. The mental foramen is small, but the small nutrient artery thus indicated is not adverse to belief in a prehensile under lip to make up for the uselessness of the teeth. The projecting nasal regions would prevent short lips from touching the ground.

The posterior position of the molar teeth indicates use for a long, slender tongue.

This species was probably quite as large as the Indian elephant, for the individual described is not adult, as indicated by the freedom of the epiphyses of the lumbar vertebræ; and fragments of others in my possession indicate considerably larger size.

The very weak dentition indicates soft food, no doubt of a vegetable character, of what particular kind it is not easy to divine. The long canines were no doubt for defence chiefly, and may have been useful in pulling and cutting vines and branches

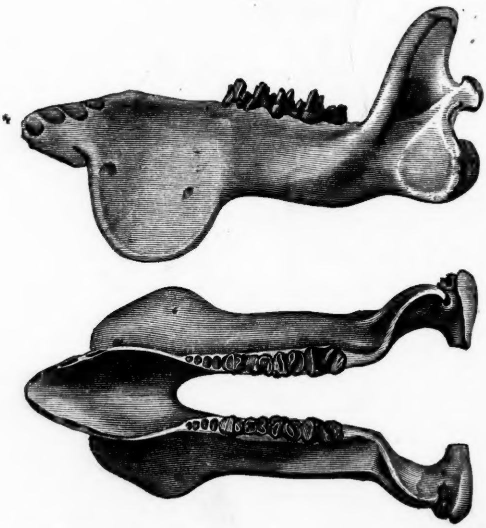


FIG. 34.—*Octotomus laticeps* Marsh, lower jaw, one-eighth nat. size; upper figure left side, lower figure from above. From Marsh, *Amer. Jour. Sci. Arts*, XI, Pl. V.

of the forest. The horns furnished formidable weapons of defence. The anterior nasal pair might have been used for rooting in the earth, if the elevation of the head did not render this impossible.

This huge animal must have been of defective vision, for the orbits have no distinctive outline, and the eyes were so overhung by the horns and cranial walls as to have been able to see but little upward. The muzzle and cranial crests have obstructed the

view both forward and backward, so that this beast probably resembled the rhinoceros in the ease with which it might have been avoided when in pursuit.

The genus Uintatherium Leidy, has the symphysis of the mandible more contracted than in the other genera, and the number of its teeth correspondingly reduced.[1] The type is the *U. robustum* Leidy, a species which is known from the posterior part of a skull with a few molar teeth of both jaws, and a superior canine tooth of one individual; and by the greater part of the lower jaw of another. It is of smaller size than those referred to Loxolophodon, and also smaller than the *U. leidianum* Osb. (Fig. 27). Besides these two species four others have been described by Marsh and referred to a genus Dinoceras, which is not yet known to be distinct from Uintatherium. The best known of these is the *U. mirabile* (Figs. 25, 26, 33), which has been well figured by Marsh. It lacks a tubercle of the last superior molar which is present in the *U. robustum.* Its lower jaw is unfortunately unknown. A species described by Marsh as *Dinoceras laticeps* is of larger size than the *D. robustum*, and Marsh figures its lower jaw (Fig. 34). It possesses four teeth on each side of the symphysis, as in Loxolophodon, but their form is not known. There is a deep flange of the lower edge of the ramus below the canine teeth, as in Uintatherium. As this form represents a genus clearly distinct from either of these, or Bathyopsis, I propose that it be called Octotomus. To this genus may belong some of the species now provisionally referred to Uintatherium.

In these animals the nasal tuberosities are small, and do not overhang the apex of the nasal bones. The median horns are anterior to the orbits, and are of various degrees of development in the different species. The posterior horns vary in like manner (compare Figs. 27 and 33). The supraoccipital crest extends much further posteriorly in the *U. mirabile* than in some of the other species.

In the genus Bathyopsis Cope, not only the incisors and canines, but also the molars are of the full number, *i. e.*, I. $_3$; C. $_1$; Pm. $_4$; M. $_3$. This, with the posteriorly extended expansion of the ramus of the lower jaw, distinguishes it from the other genera. But one species is known, the *B. fissidens* Cope, which

[1]See Cope, Proceeds. Academy Philadelphia, 1883, p. 295.

was an animal probably as large as the Javan rhinoceros (*Rhinocerus sondaïcus*), or rather smaller than the *Uintatherium robustum.*

The characters of the inferior molars in this and other genera of Dinocerata are very peculiar. In Bathyopsis they are constructed on the plan of those of insectivorous marsupial and placental mammals, so as to lead to the suspicion that its food consisted of Crustacea, or insects of large size, or possibly of thin-shelled Mollusca.

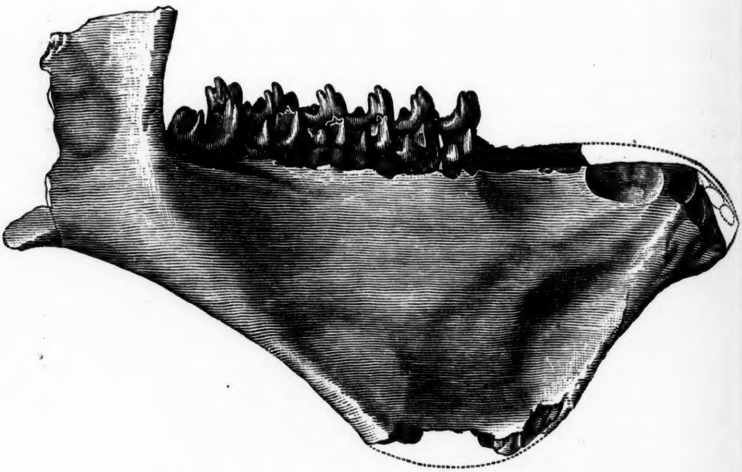


FIG. 35.—*Bathyopsis fissidens* Cope, mandible from right side, four-ninths nat. size. Specimen represented in Fig. 7. From the Wind River (Bridger) bed of Wyoming. Original, from Vol. III, U. S. Geol. Survey Terrs., F. V. Hayden.

The form of the ridges of the anterior part of the jaw of the *Bathyopsis fissidens*, together with the remarkably large dental canal and mental foramen strongly suggest that the animal possessed a large and perhaps prehensile lower lip. The lateral descending crests of the lower jaw must have affected the physiognomy curiously, especially when viewed from the front.

In the history of the discovery of the various types of the Amblypoda, we have an illustration of the prevision which the palæontologist may exercise as a legitimate inference from known facts. In closing his memoir on these animals (p. 44) Mr. Osborn remarks: "In the Upper Cretaceous or early Eocene lived a

group of animals which were the common ancestors of the Dinocerata and Pantodonta." This was written and published in 1881. In the following year, 1882, I discovered the Pantolambdidæ in the lowest Eocene bed known in America. How well this family fulfills the anticipations of Mr. Osborn may be seen by reference to the earlier pages of this essay on the Amblypoda (see NATURALIST, Vol. XVIII, p. 1111).

The tracing of the phylogeny of the Amblypoda from its earliest to its latest representatives, has presented us with an interesting chapter in brain evolution. It has been asserted[1] by Lartet, and repeated by Marsh, that there has been a continuous progress in the increase in the size and complexity of the brain in the Vertebrata, with the passage of geological time. This principle, as a whole, is confirmed by the results of my own studies. The Amblypoda constitute the sole exception known to me. The brain of the *Pantolambda bathmodon*, though of the same type as other Amblypoda, is relatively much larger than in its descendants of the Dinocerata and Pantodonta. It is a clear case of retrogression, and not of progression, in brain development.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD AND E. D. COPE.

—— The Presbyterian denomination, from the nature of its theology, is more disposed to critical and exact study than some of the other bodies of Christians. The relations of the doctrine of the evolution of species, and of the mental phenomena they display, to the prevalent theologies, are obvious. Not that it is necessary that teachers of righteousness should know all about the creation, but theology must have something to say on the subject. The discussion of these questions by Presbyterian ministers naturally produces a wider-spread agitation than in the case of Congregationalists, on account of the difference between the two churches in their system of organization, which does not give that independence to the congregation in the former that is possible in the latter. Thus while Mr. Beecher's advocacy of the evolution of man and its logical consequences, has not affected his standing in his church, when Dr. Woodrow, of the theologi-

[1] *Comptes Rendus*, June, 1868.

cal school at Charleston, S. Ca., sets forth the doctrine, the case is quite different. No less than three ecclesiastical bodies have investigated Dr. Woodrow, and he has been dismissed from his chair. Later Dr. Kellogg, of Pittsburgh, who has taught that the origin of man's body by evolution may be true, has been the object of disciplinary proceedings by the board of directors.

Since these supervisory bodies will not accept the results of the labors of the botanists and zoölogists on this subject, it would be well for them to endeavor to ascertain the facts for themselves. If they will select almost any of the genera of animals and plants which include a large number of species and individuals, and study their physical characters, they will find evidence of "origin by descent with modification," sufficient to satisfy any reasonable mind. They will reach the conclusion announced by a minister of the English Church from the north of England, at the meeting of the Evangelical Alliance held in New York a few years ago. In reply to the vigorous objections of Dr. Hodge, the author of the standard work of Presbyterian theology, he simply stated that he did not believe that the species of roses and some other well-known plants, were produced by independent acts of creation. This presentation is much more to the point than the argument, if such it can be called, of Dr. H. C. McCook, of Philadelphia, who recently took sides against the doctrine before a body of Presbyterians, in language some of which, if correctly reported, cannot be regarded as very weighty.

The loss of men like Winchell and Jordan and Woodrow is a serious one for any church. In view of the evident desire of Christians to know and teach the truth, would not the policy which has retained Drs. LeConte and McCosh in the Church, be more conducive to its future prosperity?

—— The laudable desire to perpetuate the fame of our great men of science is not only witnessed by busts and statues, but in an humble but sometimes quite as effective way by naming minerals or plants and animals after them. There are, however, different ways of doing this. Dr. David Sharp has chosen to render conspicuous both the objects of his own admiration and his own sense of what is fitting, by publishing in the "Comptes rendus de la Société entomologique de Belgique" for 1882, the following generic names of water-beetles: *Huxleyhydrus*, *Tyndallhydrus*, *Darwinhydrus* and *Spencerhydrus!* The London Entomological Society, at a late meeting, discussed the matter and

took the sensible view that "such hideous and unmeaning forms only tend to bring scientific nomenclature into contempt." The venerable Professor Westwood further remarked that "it was puzzling to imagine how any educated man (*vel doctus, vel doctor*) could deliberately write, much less print, such names; and still more, how any scientific society could allow them to appear in their transactions."

No editor or publication committee should allow such grotesque absurdities to go into print; and even then such barbarisms should be expunged; not to throw out such names, whatever nomenclatural codes are in vogue, is, we submit, an unpardonable leniency.

—— The numbers of the AMERICAN NATURALIST for 1884 were issued at the following dates: January, Dec. 29, 1883; February, Jan. 21st; March, Feb. 17th; April, March 15th; May, April 19th; June, May 17th; July, June 17th; August, July 17th; September, August 15th; October, Sept. 15th; November, Oct. 20th; December, Nov. 19th.

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RECENT LITERATURE.

MERRIAM'S MAMMALS OF THE ADIRONDACK REGION [1]—This well-written, elegantly printed volume is essentially a fresh and original contribution to the zoölogy of the Mammalia. Though restricted to the mammals of a limited area, the species have a wide geographical range, and the results of so much close observation, through a period of so many years, by a close and critical student, will be of permanent value. Sportsmen and naturalists will be under obligations to Dr. Merriam for this volume. It is purely biographical, with no descriptive or anatomical details. Moreover the matter is well presented, and will be found attractive, as we have reason to know, to boys interested in wood and field sports and nature.

The book is in the line of Audubon's Quadrupeds and Godman's American Natural History; with these works as a basis, the future student of mammals will, from work of this kind, be led more to the comparative study of coloration, of protective mimicry, of sexual selection and of instinctive and reasoning acts.

[1] *The Mammals of the Adirondack region, Northeastern New York.* With an introductory chapter treating of the location and boundaries of the region, its geological history, topography, climate, general features, botany and faunal position. By CLINTON HART MERRIAM, M.D. Published by the author, Sept., 1884. Reprinted from Vols. I and II, Transactions Linnæan Society, New York. Roy. 8vo, pp. 316.

If anything is wanting in the pages of the book before us, it is facts bearing on the psychology of these animals, such as are to be found in Morgan's work on the beaver. Studies of this kind have, however, to be mostly carried on with animals kept in confinement.

Regarding the change of color in the winter and summer pelage, Dr. Merriam has a good deal to say, as we have shown in a previous notice of the early part of this work, which originally appeared in the Transactions of the Linnæan Society of New York. Under the head of the varying hare the subject is again taken up, and the author insists that the change of color is due to the presence or absence of snow, or in his own words: "Both in spring and fall the time of the change seems to be governed by the presence or absence of snow, and is not affected by the temperature." A careful, detailed and comparative study of this subject is much needed. So far as we have looked into the matter, we have been disposed to consider Dr. Merriam's views with favor, but have learned from hunters facts which seem to show that temperature is not wholly without influence in producing the change. But why should not all of our northern mammals which do not hibernate, but are abroad when the snow is on the ground change their pelage? Why are the varying hare, ermine, arctic fox, etc., the only animals which change? Why do not the fisher and mink change as well as the ermine?

Whether the lay reader will be pleased with the use of the trinomial nomenclature remains to be seen. Perhaps occasionally useful in a strictly scientific treatise, why should not *Sciuropterus volucella hudsonius*, read *Sciuropterus volucella* var. *hudsonius;* the uninitiated reader would then understand that a well recognized variety of the ordinary more southern flying squirrel was meant. It is to be hoped that our trinomialists will not "run the thing into the ground."

We find no occasion for criticism in this admirable book, and excerpt some paragraphs concerning topics which appear new and fresh, though for that matter the entire volume smacks of out-of-door life, is redolent of the spruce and pine woods, and carries us back to the clear skies and sylvan retreats and mountain lakes of the noble Adirondack forests.

Speaking of the mole Dr. Merriam writes:

"The modification of structure that adapts this animal to its peculiar mode of life affords a most remarkable example of animal specialization. The conical head, terminating in a flexible cartilaginous snout, and unencumbered with external ears or eyes to catch the dirt, constitutes an effective wedge in forcing its way through narrow apertures; the broad and powerful hands, whose fingers are united nearly to their very tips and armed with long and stout claws, supply the means by which the motive power is applied, and serve to force the earth away laterally to admit the

wedge-like head; while the apparent absence of neck, due to the enormous development of muscles in connection with the shoulder-girdle, the retention of the entire arm and forearm within the skin, the short and compact body, and the covering of soft, short and glossy fur tend to decrease to a minimum the frictional resistance against the solid medium through which it moves. In fact, it presents a most extraordinary model of a machine adapted for rapid and continued progress through the earth.

"The mole does not, and cannot, *dig* a hole in the same sense as other mammals that engage in this occupation, either in the construction of burrows or in the pursuit of prey. When a fox or a woodchuck digs into the ground the anterior extremities are brought forward, downward and backward, the plane of motion being almost vertical; while the mole, on the other hand, in making its excavations carries its hand forward, outward and backward, so that the plane of motion is nearly horizontal. The movement is almost precisely like that of a man in the act of swimming, and the simile is still closer from the fact that the mole brings the backs of his hands together in carrying them forward, always keeping the palmar surface outward and the thumbs below. Indeed, when taken from the earth and placed upon a hard floor, it does not tread upon the palmar aspect of its fore-feet as other animals do, but runs along on the sides of its thumbs, with the broad hands turned up edgewise."

Regarding the migratory habits of the gray squirrel, which have become almost a matter of tradition, the author writes:

"The minor migratory movements of this species occur with more or less regularity from year to year, but on so small a scale as to escape general notice. They must not be confounded with the great migrations, not rare in former times, when these animals, actuated by some unknown influence, congregated in vast armies and moved over the land, crossing open prairies, climbing rugged mountains and swimming lakes and rivers that lay in their path. Though hundreds, and sometimes thousands, perished by the way, the multitude moved on, devouring the nuts that grew in the forests through which they passed, and devastating the grain fields of the farmer along the route. Though these remarkable expeditions have been known and commented upon for many years, yet our knowledge of them is limited almost to the recognition of the fact of their existence. Scarcity of food very probably gives rise to the disquieting impulse that prompts them to leave their homes, but the true motives that operate in drawing them together, and in determining the direction and distance of their journeys are as little understood to-day as they were before the discovery of the continent on which they dwell.

"In the year 1749 they invaded Pennsylvania in such vast hosts as to endanger the crops of the entire inhabited portion of

the State, and a reward of three pence a head was offered for their destruction. This necessitated the payment of eight thousand pounds sterling (640,000 individuals having been killed) which so depleted the treasury that the premium was decreased one-half."

The book is readable throughout, and its carefully prepared biographical sketches will have a permanent interest.

GRAY'S SYNOPTICAL FLORA.[1]—Everything from the pen of Dr. Gray is welcomed by the botanists of the country as a contribution from one who is a master. A few years ago a volume appeared bearing the title Synoptical Flora, which covered the ground of the Gamopetalæ after Compositæ. The volume before us, which closely resembles its predecessor, includes the gamopetalous orders Caprifoliaceæ, Rubiaceæ, Valerianaceæ, Dipsaceæ and Compositæ. The two volumes thus cover the whole of the North American Gamopetalæ, and bring our knowledge of this great group down to the present.

It may be interesting to give here in concise form some of the results brought out by this volume. By taking Bentham and Hooker's Genera Plantarum and comparing our North American composite flora with the composite flora of the world, we find that we have representatives of eleven of the thirteen tribes into which the order is now divided. We have 235 genera out of 766, or about thirty per cent of the whole. Our species (nearly 1500) constitute about four per cent of the whole.

If we look over the tribes we find the per cent of North American genera and species to be as follows:

	Per cent of genera.	*Per cent of species.*
1. Vernoniaceæ	7½	2½
2. Eupatoriaceæ	43	14
3. Asteroideæ	36	29
4. Inuloideæ	10	4
5. Helianthoideæ	46	30¾
6. Helenioideæ	70	68
7. Anthemideæ	20	7½
8. Senecionidæ	36	8⅓
9. Calendulaceæ	0	0
10. Arctotideæ	0	0
11. Cynaroideæ	19	4½
12. Mutisiaceæ	10	2¼
13. Cichoriaceæ	52	6⅓

From the foregoing table it is readily seen that our flora is rich in genera, and that it is particularly so in Helenioideæ, Cichoriaceæ, Helianthoideæ and Eupatoriaceæ. In like manner we observe that the Helenioideæ, Helianthoideæ and Asteroideæ

[1] *Synoptical Flora of North America.* By ASA GRAY, LL.D., F.M.R.S. and L.S. Lond., R.I.A. Dubl., etc., etc. Vol. I, Part II. Caprifoliaceæ-Compositæ. Published by the Smithsonian Institution, Washington. New York, London and Leipsic. July, 1884, pp. 474.

are rich in species, the first named having about five times the normal per cent. On the other hand it is interesting to notice the low per cent of species of Vernoniaceæ, Inuloideæ and tribes seven to thirteen inclusive. Curiously the North American Cichoriaceæ, which contain fifty-two per cent of the genera, include but a little above six per cent of the species!

We can take no more space here for further notice of this most valuable addition to our botanical literature. We but express the earnest hope and wish of all workers in botany that the veteran author may be spared to give us the remainder of our flowering plants in the Synoptical Flora.—*C. E. B.*

ALLEN'S HUMAN ANATOMY.[1]—This work, the issue of the first part of which was noticed in this magazine, is now completed by the appearance of Section VI, which treats of the organs of sense, organs of digestion and genito-urinary organs. This part alone contains a hundred and sixteen wood-cuts and sixteen full-page engravings. It need scarcely be said that full justice is done to the various organs mentioned in the title page, but it may be added that a chapter is devoted to the superficial and topographical anatomy of the various parts of the body, and another most interesting one to embryology and the study of malformations—a subject to which Dr. Allen has given considerable study. The illustrations are so drawn as to be especially clear to the student.

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[1] *A System of Human Anatomy, including its Medical and Surgical Relations.* By HARRISON ALLEN, M.D. Philadelphia, Henry C. Lea's Son & Co. 1883.

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GENERAL NOTES.

GEOGRAPHY AND TRAVELS.[1]

African Notes.—Capt. C. E. Gissing, R. N., has recently undertaken a journey inland from Mombasa, among the Wa-duruma and the Wa-teita, both of whom live in great dread of the Masai, who steal all the cattle they find, and kill their owners. The Wa-teita are rather undersized and are said to be very lazy, yet they live on mountain sides and summits, and cultivate the ground at the foot. The women do all the work, and carry firewood, utensils, etc., to the mountain top. Ndara, 4800 feet high, has a Wa-teita village at the top. This tribe are great robbers, but as they are armed only with bows and poisoned arrows, instead of spear, shield, and sword, they are always defeated by the Masai. Kasigao (5185 feet), has a village at 1500 feet elevation. In time of drought the natives of this part of the country sell their children as slaves to the coast people, but always redeem them in a favorable season. Although barbarous in their dealings with each other, they seem to have a horror of the regular slave trade as carried on by slave-dealing caravans.——Mr. O. Neill has discovered a lake (Lake Chiuta) to the north of Lake Shirwa, south of Nyassa. The climate of the highlands of this district (east of the Shiré) is said by Capt. Foot to be well suited to European constitutions, and adapted to wheat, oats, European vegetables, and coffee.——Lake Nyassa is becoming a busy inland sea. Two steamers ply upon it, and one upon the river Shire. There have been difficulties with the Makololo, owing to the death of their Chief Chipatula at the hands of an English elephant-hunter, but these seem likely to be settled by the efforts of Capt. Foot. On Lake Tanganyika there are now three steamers. The African Lakes Company has ten depots between Quillimane and Malawanda, on Nyassa, and from this point a practicable road has been carried to Pambete, on Tanganyika.——E. A. Floyer states that he rode from Wady Halfa to Debba, on the Nile, in

[1]This department is edited by W. N. Lockington, Philadelphia.

20¾ hours, and believes that the distance is not above 85 miles, and therefore is much exaggerated on the maps. A map of the Lower Congo, issued by the International Association in July, 1883, shows the river as flowing 100 miles more to the west than it is marked in the best recent atlases.——Gen. J. H. Lefroi, in his presidential address to the geographical section of the British Association, stated that Dr. Pogge's account of the kingdom of the Muato Yanvo (not yet translated) proved that the people were much in advance of their cannibal neighbors of Kauanda. They practice circumcision, and are a fine warlike race, but addicted to slave-hunting. Since Dr. Pogge's visit Muata Yanvo has been deposed and poisoned by the "Lukokesha," or second in authority in the kingdom, who is one of his half-sisters. The Muata Yanvo is chosen principally by the Lukokesha, but must be a son of the former king.——The Proceedings of the Royal Geographical Society for October give a list of 120 stations occupied by Europeans in Central Africa in 1884, with their latitude and longitude. Sixty-one of these are situated between the Equator and the Zambezi, east of 25° E. long., and fifty-nine west of longitude 25° E., between the equator and the Kuimén or Cunené. Twenty-six of the latter belong to the Belgian International Association, which has also four stations east of long. 25° E.——Through the letter of recommendation given by Sir John Kirk (British Agent at Zanzibar), who is in high favor with King Mandala, the ruler of Chagga, Mr. H. H. Johnston and his party are fed and clothed entirely at the cost of that potentate, who has given him a spot up the mountain (Kilimandjaro) where he can build a house and carry on his natural history work.——The Rev. W. P. Johnson has communicated to the Royal Geographical Society the result of seven years travels among the various tribes who inhabit the district east of Lake Nyassa, watered by the Lujenda and Rovuma and their tributaries. These streams rise east of the mountains which border the lake, and uniting in about 38° 10′ E. Long., flow to the Indian ocean. The district watered by them appears to be thickly peopled by settled and intelligent tribes, but the Gwangwara, a Zulu tribe that were driven northward about 30 years ago, oppress and enslave them, and the slave trade flourishes. The mountains do not exceed 4000 feet in height.

American Notes.—Dr. C. v. den Steinen, a member of the German expedition to South Georgia, has recently descended the before unexplored Xingu to its junction with the Amazons.——Another German traveler, Dr. G. Steinmann, who remained in South America at the conclusion of the work of the expedition to observe the transit of Venus, has, says Petermann's Mittheilungen, crossed the Atacama desert and ascended the Licancaur volcano to a height of 5400 meters, 400 meters below its summit. Here he found traces of ancient settlements, and of a path

to the summit.——The Danish gunboat *Tylla* has returned to Orkney from a successful expedition of four months' duration, during which a scientific exploration of the inland glaciers of Greenland was effected, and meteorological observations taken along the coast as far north as 70° N. lat. Much dredging and trawling was done, the former to a depth of 900 fathoms, and many unknown species were obtained.——A new island, in the form of a rounded flattened cone of considerable size, was seen on July 26 by the lighthouse-keeper at Cape Reykjanes, the south-west point of Iceland. Several earthquake shocks had been felt during the preceding days. A large part of one side of the cone has since slipped or fallen down into the sea.——Mr. Whitely contributes to the Proceedings of the Royal Geographical Society an account of his journey to the foot of the flat-topped mountains, Roraima and Kukenam, in British Guiana. He reckons the direct vertical sides of the latter (above the sloping part) at 1000 feet, and declares that its ascent seems impossible except by balloon. The vertical part of the Roraima seems rather less, and there is a break by which ascent may be possible. ——A report of considerable interest has been received from the Danish Expedition to East Greenland, dated Namortalik, March, 1884. Namortalik has thirty turf-covered houses, including a brewery and a bakery, also a Lutheran mission, a church, and a school. It is on an island, surrounded by several others, which are visited by the natives for seals and eider-duck. The whole southern part of Greenland is a region of wild mountains, rising in peaks to nearly 8000 feet. Close to Namortalik is the Tasermiut fjord, some 50 miles long, with a most luxuriant vegetation in summer, and with heat and mosquitos enough to make one fancy himself in the tropics.——The observations of Axel Hamberg, hydrographer of the recent expedition of Baron Nordenskjold to Greenland, are of the highest interest. Through Denmark sound, between Iceland and Greenland, flows a warm current, washing the western and northern shores of Iceland, and a cold polar current. The latter, throughout its whole course between 66° N. lat. and Cape Farewell, flows upon warm water. Its depth seems to increase with the depth of the sea, and its surface water is less salt than that of the warm current, which is thus specifically the heavier. The quantity of ice on the east coast diminishes in spring and summer, and, according to numerous observations made by Danish settlers and navigators on the south coast of Greenland, the polar drift-ice appears there in May, June and July, whereas in November, December, January and February there is no ice. Mr. Hamberg believes, therefore, that the polar current is at its maximum in spring, diminishes in force during summer, and is insignificant in autumn and winter. He hints that Nordenskjold owed his comparative success in reaching the east coast to the fact that he chose September instead of an earlier

month, and suggests that an attempt made in October or November would be still more successful.

Asiatic Notes.—*The Upper Oxus.* Mr. R. Michell (Proc. Roy. Geog. Soc., Sept., 1884) gives an account of Karateghin and Darwaz, regions situated on the upper course of the Oxus. Karateghin occupies the middle course of the Kizyl-see or Surkhab, the largest tributary of the Oxus; while Darwaz, to the south of Karateghin, lies upon the Panj or main Upper Oxus and upon the Hing-ab, a tributary of the Surkhab. These two Bokharian provinces are walled in by snow-capped mountains ten to eighteen thousand feet high, and can only be entered by ways passing over the most difficult passes. Karateghin consists of a series of hollows or expansions in the valley of the Surkhab, and each of these expansions gives evidence, from its terraced clayey sides, that it was once a lake. The smaller basins are separated by mountain spurs. Grain and fruits of the temperate climes grow in abundance in this elevated valley. The Tadjiks of Karateghin claim to be descended from the soldiers of Alexander's army, and Mr. Michell believes that the hereditary chiefs may really be so descended, but suggests that the Tadjiks themselves may be the descendants of the ancient Bactrians. The principal valley of Darwaz is the grassy and fruitful vale of the Hing-ab, whither, spite of the asperity of the roads, immense herds of cattle are driven every year from Hissar to graze.——Another well-to-do valley is that of the Saghri-Dasht, a tributary of the Hing-ab. The valley of the Panj itself has little cultivable land, but in it stands Kila-Khumb, the residence of the Bek of Darwaz. At the south-east limit of Darwaz is an impassable gorge, separating it from Roshan, which belongs to Afghanistan. Sir Hy. Rawlinson stated that Roshan was the exact Oriental rendering of Roxana, and it was here that the Bactrian chief, Oxyartes, the father of Roxana, had his residence. The Tadjik has straight, fine black hair, and deep-set, lively black eyes, and is thus quite different from the Uzbeg Tartars.

Miscellaneous Notes.—Mr. C. Winnecke has explored a part of central North Australia near the western boundary of Queensland, as far as 136° 46″ E. long. He has discovered various minor lakes and mountains and one river, the Hay, a feeder of the Marshall, but the general aspect of the country is that of a waterless desert of spinifex and low scrub, except in the valleys of the rivers, where there is grass and also gum and box trees. Eighty-five species of plants were collected, several of them new to science.——A recent work by an Austrian Slav enumerates the "Yongo slaves" or southern Slavs at 12 millions, without counting the four millions of Bulgarians. The Slavonian provinces of Austria, including Bosnia and Herzegovina contain eleven millions of Slavs. Counting Russians, Poles and Czechs, the Slavonians of Europe reach 100 millions.

GEOLOGY AND PALÆONTOLOGY.

Rodentia of the European Tertiaries.[1]—In this important monograph of 161 pages M. Schlosser has given us a much needed account of a series of Mammalia which has been hitherto much neglected. Comparatively little information as to the character of many of the European genera has been accessible hitherto, and we therefore welcome this work as filling an important hiatus in our literature. The greater number of the extinct species of Europe belong to the Hystricomorpha and the Sciuromorpha; and in the former suborder the important family of the Theridomyidæ is especially characteristic of that continent. To it M. Schlosser refers the genera Theridomys Blv. Protechimys g. n., Archæomys L. and P., and Trechomys Lart., which M. Schlosser remodels. The total number of species belonging to this family recognized, is fifteen. An important new genus is added to the Hystricomorpha, Nesokerodon Schloss., with two species from the French Phosphorites. Considerable attention is given in the monograph to the rooting of the molar teeth. The book is well illustrated with eight 4to plates.

A few blemishes appear in the text, such as the printing of the synonyms separately and in the same type as the correct names of the species. Also there is a good deal of confusion in the names and authorities which are quoted from the American literature of the subject.

Marsh on American Jurassic Dinosauria,[2] Part viii.—In introducing the description of the principal characters of the skeleton of the carnivorous Dinosauria Professor Marsh remarks that, "Although much has been written about these reptiles since Buckland described Megalosaurus in 1824, but little has really been made out in regard to the structure of the skull, and many portions of the skeleton still remain to be determined." This being the fact, "the fortunate discovery of two nearly perfect skeletons of this order, as well as a number of others with various important parts of the skeleton in good preservation, has afforded the writer an opportunity to investigate the group." The best preserved remains belong to species of Allosaurus and Ceratosaurus. The latter genus proves to be one of the most curious of the Dinosauria. Marsh finds that the bones of the pelvis are coössified as in birds; and in a subsequent article (*l. c.*) that the metatarsals are coössified also, giving a metapodium a good deal like that of a penguin. These facts quite close the argument in favor of the descent of the birds from the Dinosauria, although

[1] Die Nager des Europäischen Tertiärs nebst Betrachtungen ü. d. Organisation u. gesch. Entwickelung der Nager überhaupt; von M. Schlosser: Palæontographica, July, 1884.

[2] The principal characters of American Jurassic Dinosaurs, Part viii, order Theropoda. On the United Metatarsal bones of Ceratosaurus. *Amer. Jour. Sci. Arts*, 1884, Pt. i, 329; Pt. ii, p. 161.

in some of the pelvic characters we must, according to Baur, look to the herbivorous forms for the closest resemblance. The cervical vertebræ of Ceratosaurus have a very peculiar articulation, being deeply concave posteriorly and plane in front, thus preventing the reception of the anterior face deeply into the posterior face of the centrum in front. The depth of its shallow entrance is marked by a ledge on the sides of the anterior face. The skull of Ceratosaurus is peculiar, according to Marsh, in the large anteorbital opening.

Professor Marsh separates Ceratosaurus as type of a family distinct from the Megalosauridæ, but it does not appear from his diagnosis of the latter, on what grounds. The only distinctive character given to the former is "horn on skull," which is certainly of not more than generic value, and may not even be that. The skeleton of the Megalosauridæ is little known, but it is probable that the Ceratosauridæ must be distinguished from them by the coössified metatarsals and pelvic bones. The other distinct family appears from Marsh's definitions to be the Zanclodontidæ, where the cervical vertebræ are biconcave, and the pubes different. I have elsewhere[1] referred to Professor Marsh's tendency to exaggerate the systematic value of various characters,[2] and reiterate the opinion that his "orders" are of no higher rank than suborders.

As usual, Professor Marsh omits the customary reference to facts already determined by others. Thus he states that some of these reptiles probably rested on the free extremities of the pelvis in a sitting posture (p. 336). The writer pointed out this peculiarity as long ago as 1870.[3] Professor Marsh also finds (p. 337) that the presence of various genera of Dinosaurs, closely allied to these American forms, in essentially one horizon in the Isle of Wight, suggests that the beds in which they occur are not Wealden as generally supposed, but Jurassic. The American beds were at first referred to the Wealden by Marsh, and subsequently to the Jurassic by the writer in "Relations of the Horizons of Extinct Vertebrata of Europe and North America."[4]

This paper is well illustrated by six plates.—*E. D. Cope.*

[1] Proceedings Academy Philada., 1883, p. 97, on the structure of the skull in the Hadrosauridæ.

[2] Another illustration of this is seen in a short article by Professor Marsh immediately succeeding the first one now reviewed, "On a New Order of Extinct Jurassic Reptiles, Macelleognatha." This supposed order reposes on a symphysial portion of a ramus which looks like the corresponding part in various reptiles, and which is edentulous at its extremity. The absence of teeth or of a few teeth, does not constitute an ordinal character; so that this name must be ranged with those of Sauranodontia and Pteranodontia of the same author, as unnecessary additions to nomenclature.

[3] Extinct Batrachia Reptilia and Aves N. America, p. 122 E.

[4] Report of the Proceedings Congress Geologists, Paris; Bulletin U. S. Geol. Surv. Terrs. Vol. v.

The Eocene of North Carolina.—I have recently ascertained by the discovery of the unmistakable superposition of the small outlines of Eocene fossiliferous rocks (noted in the text and geological map of the State, in the report of 1875), and of other similarly situated patches of the same beds, with upper Eocene shells, capping the highest hills of the so-called drift or quaternary, that nearly all of these beds of sand and gravels heretofore referred to the latter horizon are of Eocene age. The area of Tertiaries in this State must now be extended over a wide stretch of country, from the tops of Laurentian hills, near Raleigh, and the higher elevations of the Huronian slates, to from fifty to seventy-five miles south-eastward, along the course of the Deep river, and so onward to the South Carolina border, reaching at one point an elevation of 600 feet above tide. This leaves the quaternary, like the Miocene, to be represented by a thin and broken covering of superficial deposits, of only a few feet to a few yards in thickness, and reaching from the coast only about 100 miles inland and an elevation but little above 100 feet.—*W. C. Kerr, Raleigh, N. C.*

Character of the Deep-sea Deposits off the Eastern Coast of the United States.—At the Newport meeting of the National Academy of Sciences, Professor A. E. Verrill gave the results of explorations made last summer by the U. S. Fish Commission steamer *Albatross*, sixty-nine dredgings having been made during four trips between Wood's Holl and a point off the Virginian coast. Of these dredgings, 5 were in depths between 2000 and 2600 fathoms (4 successful); 20 were between 1000 and 2000 fathoms; 24 between 500 and 1000 fathoms; 8 between 300 and 500 fathoms; 12 between 75 and 300 fathoms. Another trip has since been made to explore more extensively the zone between 40 and 100 fathoms.

Some very interesting and important discoveries were made in regard to the nature of the materials composing the sea-bottom under the Gulf stream at great depths. These observations are of great interest from a geological point of view, and some of them are contrary to the experience of other expeditions, and not in accordance with the generally accepted theories of the nature of the deposits far from land. The bottom between 600 and 2000 fathoms, in other regions, has generally been found to consist mainly of "globigerina ooze," or, as in some parts of the West Indian seas, of a mixture of globigerina and pteropod ooze. Off our northern coasts, however, although there is a more or less impure globigerina ooze at such depths, at most localities beneath the gulf stream this is by no means always the case. The ooze is always mixed with some mud and sand, and frequently with much clay-mud. In a number of instances the bottom at depths below 1000 fathoms has been found to consist of tough and compact clay, so thoroughly hardened that many

large angular masses, sometimes weighing more than fifty pounds, have been brought up in the trawl, and have not been washed away appreciably, notwithstanding the rapidity with which they have been drawn up through about two miles of water. In fact these masses of hard clay resemble large angular blocks of stone, but when cut with a knife they have a consistency somewhat like hard castile soap, and in sections are mottled with lighter and darker tints of dull green, olive, and bluish gray. When dried they develop cracks, and break up into angular fragments. This material is genuine clay, mixed with more or less sand, showing under the microscope grains of quartz and feldspar, with some scales of mica. More or less of the shells of globigerina and other foraminifera are contained in the clay, but they make up a very small percentage of the material.

In all our ten localities, between 2000 and 3000 fathoms, the bottom has been "globigerina ooze." We have never met with the "red clay" which ought to occur at such depths, according to the observations made on the cruise of the *Challenger*.

The temperatures observed with the improved thermometers now used on the *Albatross* were between 36.4° and 37.0° F., in 2000 to 2600 fathoms. But temperatures essentially the same as these were also taken in 1000 to 1500 fathoms, and even in 965 fathoms one observation gave 36.8° F. It follows from these observations that nearly the minimum temperature is reached at about 1000 fathoms in this region.

Geological News.—*General.*—The water of the Atlantic, Indian ocean, Red sea, and eastern part of the Mediterranean, has been shown by M. Dieulafait to contain manganese. The manganese can scarcely be perceived in sediments consisting of suspended matter, but is very perceptible when the water is free from suspended particles. In this way the well-known concretions of manganese in the deep seas were accounted for. He concludes that one of the conditions for the formation of chalk is the absence of foreign substances, and thus it may be expected that chalk should generally be rich in manganese. It was found that the quantity of manganese in fifty-six specimens of chalk from the Paris basin was fifty times more than in specimens of granular colored limestone.

Archean.—M. Barrois calls attention, in his notes on metamorphic rocks of Morbihan, to the way in which the schists gradually lose their crystalline character as they recede from the granite, until at length they pass into slate; while the metamorphic sandstones also change as they approach the granite, so as to show four distinct stages.

Devonian.—M. Paul Vernskoff has published an important memoir upon the Devonian deposits of Russia, comprising: (1) their geographical distribution in the centre and north-west of that

country; (2) a historical account of investigations of these deposits; (3) a description of their structure, and (4) a comparison of the Devonian of Russia with that of western Europe. The author concludes that the lower stages of the Devonian are lacking in Russia, which has only the middle and upper stages.

Carboniferous.—M. Fuchs has brought together abundant details respecting the geology of Cochin China and Tonkin. The carboniferous limestone is particularly well-developed, is of crystalline structure, and generally gray or blackish in tint. These rocks are violently dislocated in Tonkin and at Tourane, and form crenellated inaccessible cliffs of most picturesque shape. The islets and reefs which border the northern coast of the Gulf of Tonkin, and which have for centuries been the refuge of pirates, are formed of this rock. Upon these limestones rest beds of clay-sandstones with layers of coal at their base. These beds spread over large areas, and are certainly more than a thousand meters in thickness. Some twenty species of plants, some new, others like European coal measures, have been described. M. Fuchs then describes the coal basin of Tonkin, which forms a belt about 111 kilometers long, parallel with the coast. Only the southern border of this has been explored. The best known coal regions of Tonkin are those of Hon-Gac and of Ke-Bac. Analysis has proved that the coals of Tonkin are combustibles of good quality, adapted to diverse industrial uses.——W. Dames in remarks upon the supposed "Phyllopod" nature of Spathiocaris, Aptychopsis and similar bodies, maintains that some of these are undoubtedly goniatites, and that others cannot at present be interpreted, but that among these last none are phyllopodous.

Permian.—M. A. Gaudry announces that the study of Euchirosaurus has been facilitated by that of portions of Archegosaurus which have recently been found. Euchirosaurus possessed an abdominal cuirass, and was capable of powerful lateral motion, so that it was truly a reptile, progressing in reptilian fashion. The scales of the cuirass were very hard, and the vertebræ had neural spines which not only had lateral processes like those of several American species, but was also furnished with articular facets so as to be slightly movable upon the centrum.

Jurassic.—M. De Loriol continues, in the *Palæontologie Francaise*, the publication of his monograph of the Jurassic crinoids of France. Sixty-four species of Millericrinus alone have been described from the Jurassic beds, and twenty-six of these are new. All but four of the known species of this genus have now been found in France. No modern species recalls in the least this form of crinoid, with its pyriform or even globular calyx mounted on a long stem fixed by numerous tendrils.——M. Cotteau, in a memoir of the echini found in the limestones of the celebrated locality of Stramberg, in the Carpathians, enumerates twenty-

eight species, of which five are new, while the others have all been found in the Corallian or Kimmeridgian of other localities. The beds are thus proved to be Upper Jurassic.——In the specimen of Archæopteryx in the Berlin Museum, those parts are preserved which are wanting in the example in the British Museum, and the pelvis, hind-limbs, and more perfect tail supply valuable details. These are worked up in the memoir "Ueber Archæopteryx" in the Palaeontologische Abhandlungen, Berlin, 1884, by W. Dames.

Cretaceous.—The variability of ancient species is well demonstrated by five abnormal specimens of Hemiaster from the cretaceous of Constantine, Algeria. In some of these one of the ambulacral areas is entirely or partially atrophied, while in others there is a doubling of one of the ambulacra. These animals, provided with four or six ambulacra, attained as full a growth as normal examples.

Tertiary.—The series of tertiary deposits which lie along the Alsatian slope of the Vosges, and which are often rich in bitumen, have by M. Blecher been determined to belong to the Tongrian stage. The deposits are sometimes marly and of deep-sea origin, at others sandy and littoral, according to the widening or narrowing of the zone between the Vosges and the Black forest. The vegetable fossils are numerous and remarkable.——M. Pomel considers the terrestrial deposits of the Sahara as forming two categories. The more ancient he places in the pliocene, and names Saharian. The author endeavors to show that, during the pliocene and quaternary, the maximum zone of precipitation was displaced northwards, and successively passed from the central Sahara to the Atlas, then to central, and lastly to northern Europe.

BOTANY.[1]

THE FERTILIZATION OF THE MULLEIN FOXGLOVE (SEYMERIA MACROPHYLLA).—The mullein foxglove is similar to the passion flower of Ohio in flowering for only one day. Both begin to flower early in the morning. Seymeria perishes with nightfall, the passion flower lasts till about midnight. The Seymeria is of a yellow color, has but a short tube and is wide at the mouth. Were it not for the numerous hairs in the throat of the tube, it would be of easy access to all classes of insects. The lower hairs seem to be in decided disorder, while those on the upper parts of the tube all point to the entrance. They serve as guards to the flower, of which the lower part of the throat is incurved so as to bring the tube together at that point. The middle lobe of the lower lip has a series of hairs on either side and between these rows of trichomes is a portion free from them (Fig. 1) so

[1] Edited by PROFESSOR C. E. BESSEY, Lincoln, Nebraska.

that the rows serve the bees as a guide, leading them by means of the smooth portion directly to the stamens and style beyond.

The lower stamens appear at either side of this groove at the corolla's throat (Fig. 1), the upper stamens are shorter and entirely included. The style is slightly shorter than the lower stamens and lies between them (Figs. 2 and 4) in such a way that if the bees fail to visit it, it can be self-fertilized, *i. e.*, if the pollen of its own flower is not impotent. The stamens are erect in the bud and the style is but slightly curved forwards. In the older

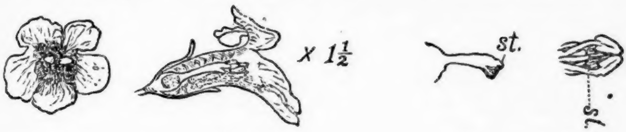


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

FIG. 1.—Flower from front view. FIG. 2.—Section of flower. FIG. 3.—The style. FIG. 4.—Stamens and style seen from below.

flowers the style is often more curved, so as to bring it into more decided contact with any entering body. The stigma (Fig. 3) is not exactly lobed, but the harder tissues at its tip are lobed, and a softer layer of tissue lies between, exuding a sticky substance. The flower is therefore but poorly specialized for cross-fertilization, the hairs constituting its only special characters. I have noticed most of the visits by bees in the evening. In the middle of the day they seem to prefer other plants.—*Aug. F. Foerste, Granville, Ohio.*

BOTANY IN KANSAS.—In the first number of the Bulletin of the Washburn Laboratory of Natural History Professor F. W. Cragin publishes lists of Kansas mosses, lichens, algæ and fungi. Of the mosses a dozen are given, determined by Eugene Rau. The lichens were identified by H. Willey, and number sixteen species and varieties. A dozen algæ are given, identified by Francis Wolle. The list of fungi includes only the Hymenomycetes, of which 158 species are enumerated. In this latter list are some new species, viz., *Agaricus alveolatus* Cragin, with a pitted pileus; *Trametes kansensis* Cragin, and *Dædalia tortuosa* Cragin. This bulletin gives promise of good work, and no doubt will do much to stimulate the collection and identification of the lower plants of the State.

FERTILITY OF HYBRIDS.—From a long article recently published by Thos. Meehan, we condense as follows, regretting that space will not permit its reproduction entire.—[*Ed.*]

The facts are that the recorded and undisputed cases of sterility in hybrids among plants are so rare that it would seem the onus should be on that side to prove the point. The writer does not know where to look for cases of undoubted hybrids among

plants that are sterile. In most cases where reference is made it has been assumed that they were hybrids, because there was some difference in appearance from the normal form, or perhaps from the simple fact of sterility alone. The curious *Pyrus polvilleriana* in the garden of the museum at Paris is a case in point. This was known in Bauhin's time, and when the knowledge of hybridism was developed, believed to be a cross between an apple and a pear. It bore fruit, but it was thought there was no seed in them. But in 1860 Decaisne cut large numbers open and found thirteen seeds in 150 fruits. In 1864 sixty-two seeds were found in 139. Now the very fact of the fertility varying with different seasons shows that sterility was in relation to the structure in connection with external circumstances, rather than to any physiological imperfection in the reproductive organs themselves. In some other locations, where the circumstances should be uniformly as they were in 1864, we should have a tolerably fertile tree. Seedlings from the tree showed a relationship to *Cratægus aria*, and, indeed, from what we know of departures from normal types without any pretensions to hybridism, one may say that there is no fair reason for regarding this curious tree as a hybrid, or the sterility as having anything to do with the question of hybridization.

The writer has a tree certainly raised from *Halesia tetraptera*, certainly no hybrid, as there is nothing near for the parent tree to hybridize with, which is so different from the parent type that it can scarcely be called a Halesia. It is as sterile as the most famous hybrid could be. In short, sterility is well known to often follow the union of two individuals in the animal kingdom, and there are innumerable cases of sterility among individual plants. Sterility will often be characteristic of a whole race, and often of a whole species; and we may say positively that there is no more sterility among recognized hybrids than we find of every-day occurrence where hybridization is certainly out of the question.

But let us give the illustrations of fertility in hybrids:

* * * Flowering plants furnish the best evidence because we know the whole history. The writer of this raised the first hybrid fuchsia. *Fuchsia fulgens* was the male parent and *F. longiflora* the female, the latter being itself a garden form. These two belonging to different sections of the genus, are not only good species, but have been regarded as of distinct genera. The progeny of these hybrids were fertile. Other hybridists used equally distinct species for the male parents, such as *F. corymbiflora* and *F. serratifolia*. All the numberless garden varieties now in existence have been raised from these original hybrids. Many successive generations have been raised. There are some sterile individuals occasionally, but not more than is found with individuals with normal species. The writer also obtained hybrids be-

tween Gesneraceous plants of two genera, *Gloxinia rubra* and *Sinningia guttata.* These were fertile. Indeed, European florists have united many supposed genera in this order. Conservatories teem with them. The writer never saw a sterile one. This is also true of Begonia. Large numbers of those in our conservatories are hybrids, all fertile. * * * * All our garden Gladioli are fertile. The original of these forms is a hybrid between *Gladiolus cardinalis* and *G. floribundus.* Our garden geraniums and pelargoniums are from many very distinct species, so distinct in appearance and general character that they might almost be regarded as distinct genera. Their offspring are occasionally sterile, but with these very few exceptions are as fertile through many score of generations as the originals. * * * * The Cape heaths of our greenhouses—species of Erica—have remarkably distinct forms among them, yet any of them hybridize freely and produce offspring as fertile as their parents. * * * * In the history of American fruits we find remarkably strong evidence for the fertility of hybrids. * * * The history of the grape in America is one of a long succession of fertile hybrids, though perhaps the distinctness of the species might be a question. There is such a regular gradation that no one can refer a form in every case to its proper species. Still, when we take the wild fox grape and compare it with the grape of European vineyards, or a scuppernong and a fox grape, all will admit that in no sense can these be regarded as one species. Yet they all hybridize, and the hybrids are fertile. * * *

M. Naudin, a very energetic French experimenter with hybrid plants, gives as the results of his observations that never more than twenty-five per cent of hybrids were sterile, and of these numbers had fertile pollen; but even this proportion may have had more to do with the climate or surroundings than with absolute sterility. In America, so far as the writer of this has had the opportunity to observe, there is no reason to believe there is any more sterility attached to hybrids than to ordinary plants.—*The Independent.*

The Younger School of Botanists.—In a recent number of *Nature* Rev. Geo. Henslow spoke of the "evil effects of the younger school of botanists not recognizing the importance of first training students in a thorough course of practical and systematic botany before proceeding to laboratory work." To this W. T. Thistleton Dyer replies with some warmth: "I am afraid I am not wholly free from some responsibility for the proceedings of 'the younger school of botanists,' the effects of which he regards as evil. In the face of the successful revival in this country of many branches of botanical study which the younger school has effected, I am emphatically of the opinion that these effects are the reverse of evil. I believe I was one of the first to organ-

ize a course of so-called laboratory work in botany on lines which it is only right to say were borrowed and extended from the teaching and example of Professor Huxley. In what I attempted I had the generous aid of many now distinguished members of the younger school. I do not doubt that they have immensely improved on the beginning that was in the first instance somewhat tentatively made. But the principle, I believe, has always remained the same, namely, to give the students a thorough and practical insight into the organization and structure of the leading types of the vegetable kingdom. When, therefore, Mr. Henslow, himself a teacher, asserts that such laboratory teaching as this should be preceded by a thorough course of practical and systematic botany, it appears to me that he is bound to explain what he precisely means by this very dark saying. For if botanical laboratory work in this country is not thorough, is not practical, and in dealing with types drawn from every important group is not systematic, it is important to know in what respects it falls short of these requirements."

NEW SPECIES OF NORTH AMERICAN FUNGI.—*Septoria purpurascens.*—Hypophyllous on small reddish-purple spots without any definite border, and often confluent so as to give a purplish discoloration to large areas of the leaf; perithecia prominent, scattered, collapsing above, 150-190μ in diam.; spores fusiform, hyaline, slightly curved, endochrome thrice divided, 30-50 × 3μ. On leaves of *Potentilla norvegica*, Adirondack mountains, N. Y., Aug., 1883. Collected by Dr. Geo. A. Rex. This can hardly be *S. sparsa* Fckl., which has spores narrowly filiform and straight, nor *S. fragariæ* Lasch., which has spores shorter and broader at one end. *S. potentillæ* Fckl., is a Gloeosporium and quite different.

Pestalozzia scirpina.—Seated under the cuticle through which the black mass of spores is visible. Conidia fusiform, 4-septate, brownish-black except the hyaline extremities, 20-25 × 6-7μ; crest mostly 3-parted, cilia spreading, 18-24 × ½-¾μ; pedicels about 10μ long. The conidia at length ooze out and stain the surface of the matrix. On culms of *Scirpus maritimus.* Collected by Dr. J. T. Rothrock in Maryland, July, 1884. *Epicoccum sphærospermum* Berk., and *Macrosporium scirpi* Lasch? also occur on the same culms.

Cercospora racemosa.—In small (1–2^{mm}) patches, greenish-white at first then brown and often subconfluent; hyphæ interwoven, branched, hypophyllous brown, 200 × 4-6μ. Conidia oblong-cylindric, sub-hyaline, 1-5 septate, 20-80 × 3-6μ, borne in a racemose manner at the tips of short lateral branches. Differs from the usual type of Cercospora in its lateral conidia and scarcely tufted hyphæ. Collected at Charles City, Iowa, Sept., 1882. On leaves of *Teucrium canadense*, by Professor J. C. Arthur.

Ovularia monilioides.—On reddish-brown, round spots, 1-4^{mm} in diameter; hyphæ fasciculate, hyaline, sparingly septate and often branched above, 35-50 × 3μ; conidia concatenate, 2-4 connected, obovate, hyaline, 12-17 × 9-12μ. On leaves of Myrica. Collected at Magnolia, Mass., June, 1884, by Miss C. H. Clarke.

Sphærella platani E. & M.—On round (2–4^{mm}) reddish-brown spots with a narrow dark but only slightly raised border. Perithecia epiphyllous, innate-erumpent (90-120μ); asci oblong 8-spored, 40-60 × 12-15μ, nearly sessile, sporidia subhyaline, ovate-oblong, 1-septate and constricted, nucleate, 14-16 × 4-6μ. Quite distinct from *S. platanifolia* Cke. On living leaves of *Platanus occidentalis.* On the same leaves, on similar spots, is a Phyllosticta which can hardly be distinguished from the Sphærella except by microscopical examination. Perithecia epiphyllous, black, about 100μ in diameter; spores oblong-elliptic, brownish, faintly nucleate, 5-6 × 2.5-3μ.—*J. B. Ellis, Newfield, N. J., and Dr. Geo. Martin.*

Botanical Notes.—The October number of *The Microscope* contains an article, by Mrs. L. R. Stowell, on the microscopic structure of *Hydrastis canadensis*, accompanied by two good plates.——Professor Trelease's paper in the Aug.-Sept. number of *Psyche*, Notes on the Relations of two Cecidomyans to Fungi, has a botanical as well as an entomological interest.——The last number (Oct.-Nov.) of the *Botanical Gazette* is devoted to the botanical aspect of the American Association for the Advancement of Science. Short abstracts are given of the more important papers read before the association and the Botanical Club. An account is given of the excursions of the club, and finally the whole is summed up in an editorial note upon the results of the Philadelphia meeting, in which, after pointing out the good results which the meeting accomplished, the editor properly criticises "the low average quality of the botanical papers presented before the association." In spite of the fact that the attendance included "some of the most distinguished names of the science in this country, the botanical communications in no instance exhibit that profound research or comprehensive statement of laws or relationships, or other characteristics that would entitle them to rank with the better papers presented by the zoölogists, physicists or chemists." We most heartily endorse the remark that "it lies with individual workers to see that this does not remain so."

ENTOMOLOGY.

C. Emery on the Fire-fly of Italy.—Luciola is one of the Lampyrid beetles, differing from Lampyris chiefly by the head being less deeply sunk in the prothorax. Both male and female have wings and elytra, the male has only six abdominal segments against seven in the female; but the terminal segment of the

male is large and bears indications of transverse division, as if it represented two somites.

Dr. C. Emery, of Bologna, was induced to examine this species (*Luciola italica* L.) by the publication of Wielowiejski's study of Lampyridæ in Zeitschrift f. Wissen. Zoologie, 1882. His own work was cut short by want of material, as last season was unfavorable in Italy; and it is only the preliminary views which he now publishes (same journal May, 1884). Some of these results are valuable.

He thinks that the female Luciola, though having wings, is unable to fly; though a friend alleged that he found both sexes flying *in copula*. The females are always very scarce, have two luminous spots on the ventral part of the abdomen (5th abdominal segment), whilst the males are common, and have the ventral parts of the 5th and 6th abdominal segments forming a large luminous organ. He is of opinion that in the imago state they never eat, and he finds the fore intestine filled with large air-sacs. [It might be well to compare this with the rectal air-sacs of larvæ of dragon-flies, and to see whether they may not be extensions of the tracheal system into the intestine, thus serving as lungs, and correlated with the great oxygen-consumption in the luminous organ].[1]

The abdomen contains the luminous organ in its ventral half, backed dorsally by a fat-body with concretions of uric acid. There are also fat masses in the prothorax, that of the male as well as its testes being rose-colored. The luminous organ is richly supplied with tracheæ, the larger tracheal trunks being *lined with bristles;* and the fine tracheal stems or branches run downwards through the luminous organ, perpendicularly towards the horizontal surface of the abdomen.

On a ventral view with weak magnifying the luminous organ is found to consist of bright round or oval areas, one of the perpendicular tracheal stems being in the center of each area, and between the bright areas are dark interspaces. The whole organ is constituted of vertical columns or cylinders, consisting of transparent tissue surrounding a tracheal stem and its branches, and the gaps between adjoining columns filled up by cellular "parenchymatous" matrix.

In a side view we can see the large tracheal trunk sending down the vertical stems, and marked not by spirals, but by transverse ridges. [This is one of the many incidental proofs coming up that the tracheal system has been misunderstood, that it is really the result of crenulations, and that there are no distinct spiral threads. Emery says: "I speak purposely of transverse ridges of chitin, and not, as is usually done, of a chitinous spiral, for such does not in fact exist here."]

By teasing the substance of the luminous plates we are able

[1] The remarks in brackets are by the reviewer.

to follow the tracheal branchings. Each stem forming the axis of a column, divides racemosely into branches, and each branch bifurcates into a pair of capillaries whose walls are perfectly smooth.

On the application of osmic acid to the abdomen of the living insect, death does not follow immediately, but the luminosity is continued for a time steadily. Long before the animal has ceased to move, the luminous plates begin to grow brown, the change proceeding from the anterior part, from the place where the tracheæ enter. The brown color becomes concentrated in round fields corresponding to the vertical columns, each surrounded by a circle of light.

The terminations of the vertical tracheal stems are enclosed in cylindrical lobular masses, the columns of the luminous organ, the tracheæ sending out its racemose branches within each column; in macerated specimens (by osmic acid and thymol) dark masses are seen where the branches bifurcate to form the capillaries; the cells of which the columns consist exhibit no nuclei. [Judging from these figures it would seem as if the dark spots represented the nuclei: if this be the case every tracheal branch is in a cell and its place of bifurcation at the cell-nucleus.]

Emery finds no case of the anastomosing of the tracheal capillaries either of the same or of different stems; he is satisfied that no such anastomosing occurs in Luciola. His view is opposed to that of Kölliker and of Wielowiejski on Lampyris. [The conclusion of Wielowiejski appears to be without sufficient foundation; his figures show only a casual collection of a few of the intricately twining tubules.]

The cylindrical lobes or columns of the luminous organ are separated from each other by a granulated substance, and the tracheal capillaries extend to this and to the granulated parenchyme-cells, penetrating between the cells but not entering them.

The dorsal fat-layer was examined for the purpose of establishing homologies. It is white, has urate concretions swimming in the plasma of its cells, which are not distinctly limited by cell walls; but it has nuclei like those of the parenchyme of the luminous organ; and these facts as well as the tracheal arrangements favor the view that the luminous parenchyme is derived from the fat-body. It cannot be that the latter with its urate concretions is the result of combustion in the luminous organ, for the tracheal arrangements negative such a view.

In comparing Lampyris, Emery concludes that M. Schultze's tracheal end-cells are represented in Luciola by the bright cell-elements of the luminous cylinders enclosing the tracheal stems; that the tracheal branching is similar; also that the reactions are the same, osmium being precipitated so as to darken the substance in both cases. In Luciola there is a higher differentiation of parts.

Transversely striped tracheæ never enter the fat-masses of Luciola; it is only the smooth tracheal capillaries that pierce them, somewhat coarser than those of the luminous organ, and retaining air in their lumen. The fine branches here arise not in a racemose manner, but by a fascicle of two or more capillaries arising at a point, and running in complicated windings before they enter the fat masses. They were never seen to anastomose; the layer of matrix was very thin on the striped tracheæ, but much thicker on the capillaries. Sometimes the ends of the capillaries lying on a cell of the matrix were free; between two capillaries the matrix often formed a thin web, and rarely the matrix was gathered into a globule terminating the capillary. Real tracheal end-cells were not seen.

As to the physiology of the luminous organ, the seat of the luminosity is at the boundary between the tracheal cylinder and the parenchyme-matrix around it: this is the place where the capillaries begin and where the osmic acid is reduced by the illumination, where oxygen is consumed. [Here we have an additional argument for the doctrine that the oxygenation of the tissues depends not on a circulatory fluid around the tracheæ, but on the activity of the tracheal terminations.] The action of osmic acid at this part is an *experimentum crucis*, proving that at the bifurcation the plasma of the parenchyme coming to meet the fine tracheal capillaries, receives oxygen from them, and hence combustion arises where the chitin of the capillaries is very thin.

Emery holds that the use of the light-producing power is not merely for attracting the rare females, but for frightening such nocturnal enemies as bats. Luciola on being crushed emits an unpleasant flavor, but its taste is not at all bitter.—*G. Macloskie.*

Entomological Notes.—A case of mimicry is noticed by C. M. Weed in the same number; *Tetracis lorata*, a white geometrid moth was found adhering to the stamens of a flower of the may-apple, its head toward the center, the wings being easily mistaken for the petals; a second one was found in exactly the same position.——E. L. Ragonot, 12 quai de la Rapee, Paris, is working out the Phycidæ and Galleridæ of the whole world, with a view of monographing these groups, and desires American specimens; European microlepidoptera will be sent in return.——At a recent meeting (July 2) of the London Entomological Society, Mr. C. O. Waterhouse exhibited various species of phytophagous beetles to show the extraordinary effect that exposure to light had produced on their colors. Fiery red had turned to bright green, pale yellow to brown, blue to black, and green to purple. The specimens exhibited had been in the public galleries of the Bristol Museum for twenty-five years.——In *Zoologischer Anzeiger*, July 7, P. Pancirtius publishes a note on the development of the wings in insects; in the same journal for July 21, E. Korschelt begins

an account of his observations on the structure of the chorion and micropyle in the eggs of insects.——Professor A. S. Packard, Providence, R. I., desires alcoholic specimens of Poduridæ and other Thysanura with a view to a future monograph of this order. He will gladly name any specimens sent him for identification. ——Dr. Heylaerts publishes in the Compte-rendu de la Société entomologique de Belgique (p. CCVII), remarks on the Psychides of the United States. He believes that other genera of these sack-bearing caterpillars will be discovered, such as the Epichnopteryx, Bijugis and Fumea, though he adds that not an European species has yet been discovered here. He describes from Professor Riley's collection *Chalia rileyi*, and notices a series of seven cases of unknown species, all, except one from Brazil, being from the Southern and Western States and Territories.——An Asiatic species of Corydalus (*C. asiatica*) resembling in size and appearance our *C. cornutus*, is described and figured by J. Wood-Mason in the Proceedings of the Zoölogical Society of London (1884, p. 110). It occurred at the Naga hills, N. E. frontier of India. All the previously described species of this genus are American.

ZOÖLOGY.

THE DEEP SEA EXPLORATIONS OF THE "TALISMAN."—The official report by M. A. Milne-Edwards, of the last expedition of the *Talisman*, has been published and translated by the *Independent*. The expedition of 1883 was divided into several distinct steps, the aim being to examine: 1. The coast of Africa as far as Senegal, then the shores of the islands of Cape Verde, of the Canaries and Azores, and, finally, to examine the Sargasso sea and study its surface fauna as well as the nature of its depths.

In one of the first trials on the coast of Spain, the *Talisman* party found an accumulation of dead shells, having the aspect of the pliocene fossils of Sicily, and among which M. Fischer recognized *Cypridina islandica* and *Mya truncata*, which are common in boreal seas and do not live south of England. They were associated with some Mediterranean or pliocene shells. Off the coast of Morocco and the Sahara were found, at the depth of 500 to 600 meters, numerous fishes (Macrurus, Melanocephalus, Hoplostethus and Pleuronectes), crustaceans such as certain undescribed shrimps with an enormous rostrum, pointed like a sword, which was named Pandales; other shrimps of the genera Penæus, Pasiphaea, some small crabs (Etalia, Portunus and Oxyrhynchus), some red Holothurians, examples of the soft-shelled sea-urchin (Calveria), which formerly lived in the chalk formation; also many large-sized sponges, some in the shape of an enormous chapeau (Askonema), the others lamellated (Farrea), the others more or less globular.

Deeper down, toward 1000 and 1500 meters, fishes abounded;

there were still Macruri, to which may be added species of Bathynectes, Coryphenoides, Malaccocephalus, Bathygadus, Argyropelecus, Chauliodus, Bathypterois, with fins transformed into tactile appendages (*B. longifilis*), Stomias, Malacosteus, with the skin of an intense black, and with phosphorescent jugal plates; Alepocephalus, etc. All these fishes, on arriving at the surface, were dead, the gas was separated from the blood, so as to produce a sort of froth, and many of them were deformed by the enormous distention of their swimming bladder. The species of this group, which inhabit the abysses of the sea, have a special aspect, and are readily recognizable. Their skin, covered with a very thick coat, never has lively colors; it is grayish, or of a velvet black, and the scales are not very solidly attached; the muscles are not thick, and are of a soft consistence; their bones are soft and have a spongy structure; their mouth is usually large, and armed with sharp, hook-like teeth. Most of these fishes live in the ooze, or at its surface. All that were observed by the *Talisman* party had normally developed eyes, whose mode of action in a medium completely obscure would be difficult to understand, if it did not find its explanation in the existence of phosphorescent plates, or of a covering of luminous slime, which can shine at a certain distance. In the black Malacosteus these plates are situated at the eyes; in other species they are disposed in lines on the lateral parts of the body.

The Pandali have given place to the Heterocarpus, with the carapace furnished with projecting edges; to species of Penæus, whose posterior feet resemble antennæ, and to enormous shrimps of a blood-red color, and with extremely long antennæ, which were previously unknown, and should be placed in the genus Arista.

These crustacea were common, and several times they were caught in such abundance that the cook claimed his share of them. The Nephropsis appeared at this level; they are blind crustacea, which externally resemble some kinds of crayfishes, of a coral red. Their geographical distribution seems to be very extensive; for they have been found on each side of the Atlantic, in the Antilles, while a Chinese species which seems to be identical, at least very near, has been dredged at a great depth near the Andaman islands.

The Pentacheles and the Polycheles, whose eyes are atrophied, conceal themselves in the ooze, only extending their long, slender pincers adapted to seize their prey. They alone represent in actual nature the Eryons, so common in the jurassic seas.

The Nematocarcini, with remarkably long feet, live in the same conditions. The crabs have become rarer, though some species still exist. These are the Maians (Scyramathia, Lispognathus), some Homolians of a new species, Lithodes of great size, heretofore peculiar to Arctic and Antarctic seas. A very large Lithodes

was dredged by the *Talisman*, under the tropics, at the depth of 900 and 1000 meters. This species, distinct from all others yet known, has been named *Lithodes tropicalis*. There also occurred several crustacea of the group Galatheæ, whose eyes are transformed into spines.

The sponges are extremely common at the surface of the bed of this part of the ocean. Most of them, as well known, have a silicious skeleton.

Several species of the beautiful Rosella and of Holtenia were found living in profusion. Their long hairs of white silex are buried in the mud, and the sponges, with a form like a rounded vase and a narrow orifice, project above the mud. They were especially numerous between 900 and 1200 meters, and at certain points they seem to form veritable beds. The Aphrocallistes, whose solid framework, composed of regular cells, affects the most elegant forms, and gives the appearance of a honeycomb, form extensive banks; they were found ordinarily associated with, and attached to, branching corals of the genera Lophohelia and Amphihelia.

The soft sea-urchins, such as the Calveria, become more numerous, and at 1000 meters they probably live crowded together like the Echini of our shores. Some Holothurians, of the genus Loetmogone, and other species of the same family creep among them; numerous starfishes, Ophiurans and Brisingas, are also associated there. Otherwise the fauna changes according to the nature of the bottom, and where the mud gives a foothold to the polyps, we find in these new conditions a different population.

Off Cape Ghir and Cape Noun, under the 30th parallel, at 120 miles from the shore, the *Talisman* explored, for several days, a very regular bank, whose depths only varied between the narrow limits of 2075 to 2300 meters. It was on this same bank that, on the 2d of August, 1882, the *Travailleur* brought up in its nets the singular fish described by M. Vaillant under the name of *Eurypharynx pelecanoides*, associated with a great number of new or rare species. This year two specimens of Eurypharynx have been captured, one at 1050 meters and the other at 1400 meters, on the bottom of the reddish ooze west of Morocco. Similar banks, but less rich, had been already explored by the *Talisman* on the Morocco coast, off Rabat, between Cape Blanc, northerly, and Cape Cantin, a little before the arrival of the *Talisman* at Mogador. These were found again under the 24th parallel; also off the Arguin bank. At this depth, the fishes were represented by some very rare species, such as the *Melanocetus johnsoni*, which had been as yet known only by a single example found floating on the water by fishermen near Madeira. With its enormous mouth it could swallow a fish considerably larger than its own body, and its prey would lodge in a sac which hangs below its abdomen. The first ray of the dorsal fin is developed into a true

tactile appendage, recalling that of the anglers, and serving the same purpose. Some Bathytroctes, a Stomias with phosphorescent plates, several Malacostei and some Halosaurus live also on the same oozy bottom. Many Crustacea, new to science, were here dredged, and belonging principally to the group of Galatheæ of the genera Galathodes, Galacantha, and Elasmonotus, whose eyes, deprived of any cornea, are covered with an orange colored pigment, and should be useless for vision. With them were dredged several new kinds of mollusks, among them a Dentalium of large size (*D. parfaiti*) and a Pholadomiya.

Between Senegal and the Cape Verde islands, the bottom, at a depth of from 3210 to 3655 meters, consisted of a greenish mud rich in life. Some of the animals found there did not differ from those found on the bank situated at the depth of 2300 meters.

Others presented peculiar characteristics. These were fishes of the genus Bathynectes, Synaphobranchus, and Myrus, some Aristes, with bright colors and very like those at depths of from 1000 to 1200 meters, but with smaller eyes. Among Crustacea were Pasiphaës, hermit crabs and Mysidæ. Among mollusks were a new species of Bulla, and another gasteropod belonging to an unknown genus (*Oocorys sulcata* Fischer); among Echinoderms were species of Ctenodiscus, Ophiurans, and species of Ophiomusium.

Between St. Antoine and St. Vincent the fauna surpassed in richness any regions previously explored. July 29th, at a depth of from 450 to 600 meters, the dredge came up at the end of an hour charged with more than a thousand specimens of fishes belonging mostly to the genus Malacocephalus; with more than 1000 Pandali, 500 amphipods, with long feet, a new species of Nematocarcinus, 150 Pasiphaës spotted with red, large carmine-red Aristes, and many other forms.—*To be continued.*

The Depth to which Sunlight Penetrates Water.—The much-discussed question as to the depth to which sunlight penetrates water, and the influence which such penetration, or want of penetration, may exert upon the phenomena of life at great depths has attracted renewed attention of late on the part of both physicists and biologists. The carefully conducted observations of Professor F. A. Forel, of Geneva, made upon the Lake of Geneva in 1874, proved—at least as far as the resources of photography and the human retina permitted—that the limit of absolute darkness in that lake was reached in summer at the very moderate depth of 45 meters, and in winter at 100 meters. Under normal conditions of sight a shining object disappeared when immersed below 16 to 17 meters. Asper, who continued the researches of Forel upon the Lake of Zurich, found in 1881 that photographic plates sensitized with bromide of silver emulsion indicated the penetration of light to at least 90 meters. But while the researches here recorded fix the limit of luminous perception as

dependent upon the powers of the human retina, they do not necessarily determine the same for the retina and visual nerves of the lower animals. Indeed, the presence of well-developed eyes in many of the animal forms inhabiting the greatest depths, no less than the varied coloring of their teguments, have frequently been taken in evidence to prove not only the existence of light there, but also the unequal visual powers of the different organisms. Professor Verrill has recently enunciated the startling proposition that not improbably light of the intensity of ordinary moonlight may penetrate to depths of 2000, or even 3000 fathoms, and that possibly some sunlight penetrates even to the lowest bottom of the ocean. Evidently, however, the tegumentary coloring as we observe it has no bearing on the question at issue, inasmuch as it appears as such only when brought within the influence of white light, which may be at, or quite near to, the surface of the water. Whether or not the quantity of phosphorescent light emitted by the organisms themselves is sufficient to account for the full development of visual organs, still remains to be proved. In the meantime, the recently conducted investigations of a special committee of Swiss scientists, among whose names we find those of Sarasin, Soret, Pictet, C. De Candolle, and Fol, seem to affirm in a general way the conclusions reached by Forel—namely, that luminous penetration extends to only moderate depths. Three candles (contained in a lantern), immersed in the clearest water of the Lake of Geneva, were visible at a depth of 30 meters; and an electric light, at 3 meters further. The distance of clear vision was found to be but very feebly dependent upon either the increase of brilliancy in the luminous body, or its absolute magnitude. The extreme limit of the sun's luminous action was determined photographically to be 250 meters, beyond which absolute darkness was supposed to prevail. —*The Nation.*

On the Structure of the Brain of Asellus and the Eyeless form Cecidotæa.[1]—The results presented grew out of an attempt to compare the nervous system, particularly the brain and other cephalic ganglia, of the eyeless species of cave-inhabiting Crustacea and insects with the allied eyed forms. After describing the brain and organs of sight of the common water sow-bug (*Asellus communis*), with it was compared those of the blind asellid, *Cecidotæa stygia* Packard, which is so common in the brooks of Mammoth and other caves, and in the wells of southern Illinois and Indiana. Studies of this nature seem well calculated to throw light on the origin of the cave forms, and to show what great modifications have been produced in these organisms by a radical change in their surroundings; consisting as the latter do mainly of the absence of light and perhaps of the usual food, or at least the usual amount of food.

[1] Read at the Newport Meeting of the National Academy of Sciences, Oct. 4, 1884.

After describing the hitherto unknown peculiarities of the brain of Asellus and isopod Crustacea in general, the histological elements, and the optic lobes, nerves, and eyes, the brain of the eyeless forms was then described. Cecidotæa in its external form is a somewhat dwarfed Asellus, with the body, however, much longer and slenderer than in the eyed forms, and with slenderer appendages. It is not usually totally eyeless, since in some individuals a rudimentary eye, in the shape of a minute black speck, is seen on each side of the head; the spot varying in size in different individuals.

From the examination of numerous microscopic sections it appears that the eyeless Cecidotæa differs from the eyed form (Asellus) in the complete loss of the optic ganglia, the optic nerves, besides the almost and sometimes nearly total loss of the pigment cells and lenses. As regards the other parts of the brain, no differences were observed; the proportions of the brain and the histological structure had remained unchanged in the eyeless forms. Besides the atrophy of the optic ganglia and nerves, the pigment mass forming the retina and also the lenses exist in a very rudimentary condition. In one specimen the number of lenses was reduced to two, and the lenses themselves many times smaller than in the eye of the normal Asellus.

The steps taken in the degeneration or degradation of the eyes, the result of living in perpetual darkness, seem to be these:

1. The total and nearly or quite simultaneous loss by disuse of the optic ganglia and nerves.

2. Breaking down of the retinal cells.

3. The last step being, as seen in the totally eyeless forms, the disappearance of the lens and retina.

That these modifications in the eye of the Cecidotæa are the result of disuse and the loss of the power of vision from the absence of light seems well established; and this, with the many parallel facts in the structure of other cave Crustacea, as well as insects, arachnids, and worms, seemed to the author to be due to the action of two factors: (*a*) change in the environment and (*b*) heredity. Thus one is led by a study of these instances, in a sphere where there is little if any occasion for the exercise of a struggle for existence between the organisms, to a modified form of Lamarckianism in order to account for the origination of these forms, rather than the theory of natural selection, or pure Darwinism, as such.—*A. S. Packard.*

On the Morphology of the Tarsus in the Mammals.—While occupied with an extended paper on the limb-skeleton of the vertebrates, I have obtained some new views on the homology of the tarsal elements in the Mammalia. For some time I have been puzzled by a bone in the tarsus of different mammals, which has always been considered a "*sesamoid.*"

Flower (Osteol. of Mamm., 2d edit., p. 317) says of this bone:

"There is a large sesamoid bone on the tibial side of the tarsus, articulating with the astragalus, navicular and internal cuneïform."

Gegenbaur, who has done so much for the morphology of the limbs of vertebrates, says in regard to this:[1]

"Eine Vermehrung der Tarsuselemente ist bei Nagethieren vorhanden, von *Cuvier* wie von *Meckel* ausführlich beschrieben. Es wird diese Vermehrung aus einer Theilung des Naviculare abgeleitet und aus dem Hinzutreten eines überzähligen Knochens, der am inneren Fussrande des Cuneiforme 1 angelagert ist. Der aus der Theilung des Naviculare entstehende zweite Knochen liegt gleichfalls am inneren Tarsus rande, hinter dem vorhin erwæhnten, ist dem Kopfe des Astragalus seitlich angefügt und stösst überdies noch mit dem eigentlichen Naviculare und auf eine kurze Strecke mit dem Cuneiforme 1 zusammen. Wenn auch seine Lagerung am Astragalus und seine Verbindung mit dem eigentlichen Naviculare die Ansicht von seiner Entstehung, wie sie die oben genannten Autoren äussern, als sehr wahrscheinlich erscheinen lassen, so halte ich sie doch noch nicht für fest begründet. Das Vorkommen des zweiten Knochens, sowie ähnlicher überzähliger Stücke am Tarsus der Monotremen schliesst die Möglichkeit nicht aus, dass auch das aus einer Theilung des Naviculare entstanden sein sollende Stück ein Accessorium ist. Daran wird wenigstens so lange festgehalten werden dürfen, bis der Nachweis einer Theilung der Naviculare aus der Entwicklung geliefert ist."

I do not consider this bone a sesamoid for the following reasons:

1. Its situation. It articulates by distinct and well-developed faces with the first cuneïform (Tars. 1), at the proximal prolongation of which it is situated, and with the navicular and astragalus. In many *rodents* it articulates with the entire surface of the first cuneïform.

2. Its origin. In Cavia it is always found equally developed with the other tarsal bones and quite distinct.

3. Its relationship in certain phylogenetic old rodents, Cercolabes and Erethizon. In these forms there is always developed a claw-like piece of bone, articulating with the "sesamoid" in question, and hence it loses all the characters of a "sesamoid." It is surrounded by the astragalus, navicular, cuneïform 1 and the claw-like piece.

G. R. Waterhouse (A natural history of the Mammalia, Vol. II, Pl. 18, Fig. 4) gives an excellent figure of the tarsus of *Cercolabes novæ hispanæ*, but he calls these elements "supernumerary bones" (pp. 405–406).

Let us examine the relationship of this bone in some other orders

[1] Gegenbaur, C. Untersuchungen zur vergleichenden Anatomie der Wirbelthiere, 1 Heft. Carpus and Tarsus. Leipzig, 1864.

of mammals. In Hyrax I find a small bone between the astragalus and navicular, which I can only homologize with the "sesamoid." In the carnivores it appears to be coalesced with the navicular, as in Lepus, for I always find in the ascending part of the navicular traces of a former separation. In an embryo of a dog of 65^{mm} I have observed indications of a former distinction. In a recent examination of Ornithorhyncus[1] I have observed the same condition as in Cercolabes; the spur of the former is homologous with the claw-like piece in this rodent. A similar condition is found in many Edentates.

The question now is, what is the homologue of this bone? I can only compare it with the tibiale. The astragalus would then be homologous with the intermedium, the calcaneum with the fibulare.

I reach the conclusion: First, by the position of the piece in question; it lies in the first row of tarsal bones next to the astragalus; second, by the development of the tarsus of mammals. I never have been able to distinguish an "intermedium" in the sense of Bardeleben. In embryos of mammals, I have always found the astragalus composed of one piece, and I never find an element between the astragalus and calcaneum. In adult mammals, especially in Marsupials, I find Bardeleben's "intermedium" well developed, but I only consider it a tendon ossification.

The terminology of the tarsus of mammals would be the following:

Tibiale	=	Sesamoid.
Intermedium	=	Astragalus.
Fibulare	=	Calcaneum.
Centrale	=	Naviculare (Navic. = Centr. + Tib.).
Tarsale I	=	Cuneiform I.
Tarsale II	=	Cuneiform II.
Tarsale III	=	Cuneiform III.
Tarsale IV + V	=	Cuboideum.

If we seek for connecting forms among the vertebrates below the mammals, we must bear in mind the Theromorpha from the Permian recently described by Cope, which show so many resemblances to the mammals, especially in the tarsal bones. I do not hesitate to consider the claw-like piece in the tarsus of Cercolabes and Erethizon and the spur in the monotremes as the rudiment of a sixth toe, and would like to compare it with the same structure seen in the tarsus of frogs.

In my paper on the morphogeny of the carpus and tarsus of the vertebrates I will speak further on this subject.—*Dr. G. Baur, Yale College Mus., New Haven, Conn., Oct., 1884.*

ZOOLOGICAL NOTES.—*Cœlenterates.*—Messrs. Koren and Daniellsen have recently described fifteen new species of Alcyona-

[1] Cope, E. D., Paleont. Bull. No. 39, p. 46, 1884.

rians, most of which have been dredged in the Bergen and Drontheim fjords. The new genus Duva contains four species. It contains much branched forms, bearing several non-retractile polyps at the extremity of each branchlet. The polyps are provided with long acicular spicules, and branches, twigs, and septa are without calcareous deposit. *Gorgonia florida* Rathke belongs to this division. Another new genus Gondu, is so peculiar that it is considered the type of a new family of Pennatulids and even of a section of the order characterized by the fixity of the rachis, the presence of long calcareous spicules and the bilateral development of the pinnules. The colony is short and without a base. The spicules have a central canal, divided into four by septa. The only species, *G. mirabilis*, is of a beautiful orange, with dark red polyps. The remaining species belong to the alcyonarian genera Sarcophyton, Gersemia, Clavularia, Sympodium, and Haimea, the gorgonian genera Brianeum and Paragorgia, and the pennatulid genera Gladiscus, Kophobelemnon, Leptotilum and Pinnatula.

Worms.—M. J. G. de Man, of Leyden, has published a monograph of the nematodes of the Netherlands and of France. He describes forty-three species belonging to thirty-six genera, of which twenty are new. Terrestrial nematodes can usually be found in the earth attached to the roots of damp grass, and fresh created species abound upon the filaments of Confervæ and in the detritus of ponds and brooks.

Crustaceans.—Crustacea seem to be rare in Barentz sea, for the six Dutch expeditions have only obtained fifteen species. M. Weber, in the *Niederländische Archiv fur Zoologie*, gives a careful description of *Glyptonotus sabini* Kroyer.

Fishes.—Cases of hermaphroditism among fishes accumulate. Aristotle first noticed it among the Serranidæ, and his statements have been since verified. The peculiarity has been observed in three or four species of Serranus, and in sixteen other species of bony fishes, viz.: *Box salpa*, *Charax puntazza*, *Chrysophrys aurata*, *Labrus mixtus*, *Pagellus mormyrus*, *Perca fluviatilis*, *Sargus annularis* and *S. saloaini*, *Scomber scomber*, *Gadus morrhua*, *G. merlangus*, *Lota vulgaris*, *Solea vulgaris*, *Clupea harengus* and *Cyprinus carpio*. The majority of these species are Physoclysti, but three are Physostomes. Hermaphroditism has also been observed among the Chondrostei (*Acipenser huso*, *A. sturio*), but not among the elasmobranchs or the dipnoans. In examples of *Centrolophus pompilio*, *Smaris alcedo*, and *Ophidium barbatum*, a mass of ovules has been seen to develop within the male gland in the midst of the spermatoblasts. M. Max Weber (Ueber Hermaphrodismus bei Fischen. Nied Tijd. vor der Dierkunde) gives an interesting anatomical description of two hermaphrodite fishes, a perch and a cod. He attributes hermaphroditism to the primordial sexual indifference

of the materials at the expense of which the genital glands are developed. This makes it possible that, while one part of these embryonic materials evolves the male sex, the other may suffer modifications in the direction of the female.

Reptiles.—The lizards of the genus Macroscincus, which are not known to occur on any other spot than the desolate volcanic islet of Branco, three and a half miles south-west of Santa Lucia (Cape Verde islands) are said by M. A. Milne-Edwards to be exclusively vegetable feeders of exceedingly timid disposition. They live in holes among the loose basaltic masses which strew the island. The largest example obtained by the naturalist of the *Talisman* was sixty centimeters in length.

Birds.—The report of the committee for obtaining observations of the migrations of birds at light-houses and light-vessels around and near the British islands, contains much interesting information. Light-vessels moored from five to fifty miles off shore are most favorably placed for such observations. At Heligoland, the rush of migrating birds is more marked and concentrated than anywhere on the English coast. The great rushes on the English east coast in 1883 were on September 21 and the two following days, with moderate cross-currents of air blowing over the North sea, on October 12 and 13, and from the 27th to the 31st of the same month. No less than eight Greenland falcons were shot on the west coast of Ireland during the past year. Not a tithe of the enormous immigration of the autumn returns by the same lines in the spring.

Mammals.—M. A. Milne-Edwards stated in 1871 that, as a result of an examination of the foetal development of Indris, Propithecus, and Lemur, he had concluded that the lemuroids had incontestable affinities with the herbivores. Since that epoch, M. A. Milne-Edwards has examined the embryos of Microcebus, Galago, etc., which yielded the same results, and lastly has dissected a foetus of the aye-aye. This was found to resemble in every essential character those of other lemuroids, while the foetal membranes were those of a typical lemur. The dentition of the young aye-aye is much less different from that of other lemurs than that of the adult, in consequence of the shedding and non-replacement of some of the milk-teeth. The abnormal characters of the species are developed as age advances.

EMBRYOLOGY.[1]

An Outline of a Theory of the Development of the Unpaired Fins of Fishes.[2]—The median fins of fishes normally present five well-marked conditions of structure which correspond inexactly to as many stages of development, which, in typi-

[1] Edited by John A. Ryder, Smithsonian Institution, Washington, D. C.

[2] To appear in full in the Proceedings of the National Museum, with plates.

cal fishes, succeed each other in the order of time. A sixth exceptional form is developed in consequence of an extensive degeneration of the chordal axis and hinder end of the urosome, unaccompanied by an upbending of the hinder end of the axis, as in the case of the evolution of heterocercy. The most primæval stages, or those found to appear in the younger phases of the growth of fishes are somewhat approximated by the structure of the fins of some of the most ancient Devonian, Triassic and Jurassic forms and by such living forms as Chimæra, the Dipnoans and Leptocardians, but the parallelism of the development of the tail of young fishes with the successive modifications of caudal structure found in the forms of successive geological periods is not exact, as we shall presently show.

1. *Archicercy.*—The most primitive modification of the urosome is that which I will call *archicercal*, and which is without any median fin-folds whatsoever. While it is true that only a few degenerate or specialized forms of true fishes (Hippocampus, Nerophis) approximate such a condition, it must be admitted that the fins are acquired structures, and that the folds from which they are developed have been acquired in the course of the evolution of the ancestry of the fishes. When a young fish is developing in the egg its tail grows out at first as a blunt prolongation backwards, which is for a time wholly without fin-folds, cylindrical and vermiform in general appearance, with the muscular somites clearly marked.

The larva of Branchiostoma (Fig. 1) is at first without median

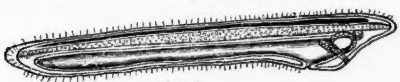


Fig. 1.

fin-folds, and that of Petromyzon seems to be without them during the very early stages, and while we must make due allowance in both these cases for the effects of degeneration, we may, I think it probable, look upon these types as possessing at one stage a typically archicercal and vermiform tail. The solitary Urochorda or Ascidians pass through an archicercal stage of development of the urosome. In the course of further development the Ascidians never seem to pass beyond what I have called the second or lophocercal stage when it is absorbed in the caducichordate forms, but persists in the same stage in the perennichordate Appendicularia.

The Elasmobranchs seem to pass through an archicercal stage while the Amphibians do not exhibit it in so pronounced a way, very soon becoming lophocercal, though the larva of Dactylethra has the anterior part of the urosome with high median fin-folds while the termination is somewhat like that of *Chimæra monstrosa* (Fig. 2), but tapers more and is typically archicercal (*teste*, W. K.

Parker). After the absorption of the lophocercal tail of anurous amphibian larvæ has been in progress for some time, it seems to

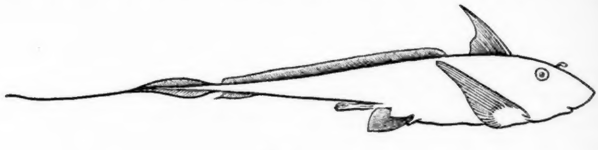
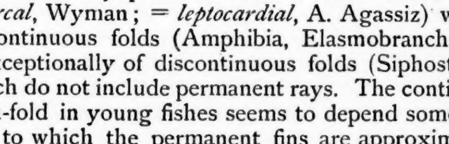


Fig.2

tend to lose its median folds somewhat and revert to the archicercal condition. This is also the case with the young of most Urodela as they approach maturity.

2. *Lophocercy.*—The second stage of development of the median fin-system of Ichthyopsida is what I have called *lophocercal* (= *protocercal*, Wyman; = *leptocardial*, A. Agassiz) when it consists of continuous folds (Amphibia, Elasmobranchs, Teleosts, etc.), or exceptionally of discontinuous folds (Siphostoma, Gambusia) which do not include permanent rays. The continuity of the median fin-fold in young fishes seems to depend somewhat upon the extent to which the permanent fins are approximated in the adult. Several forms amongst the Clupeoids develop an expanded eradiate caudal fold, with the chordal axis dividing it into equal moieties, which anticipates the form of the outwardly homocercal tail of the adult. At the close of the lophocercal condition the ray-bearing fishes at once diverge from the rest of the Chordata, and also the Urochorda, in that they develop *embryonic rays* in definite regions of the median fin-fold or continuously throughout its entire extent and which give rise to the rays of the distinct or continuous fins of the adult. The intervening parts of the fold in the first case atrophy (—local reversion to archicercy),

Fig. 3.



the materials for the formation of the rays being supplied partially by mesoblastic secretion, while the axial parts are of mesoblastic origin; the materials for the medulla of the rays being supplied by the outgrowth of mesoblast into the fold. The disposition of the materials for the development of the rays of the unpaired fins seems to be very decidedly under thê control of heredity, which determines their permanent location or position in

the primitive fold, which may therefore be considered the matrix of the permanent fins.[1]

In the formation of rays, their supports and musculature, there is clearly a close correspondence between the number of ray-bearing somites of the body and the one, two or three rays and supports which are developed to each segment, and this is manifested even when heterocercy and its accompanying degenerative processes manifest themselves in the caudal region of the most specialized forms.

3. *Diphycercy.*—The most archaic distribution of the median fin-rays is a continuous one, (as in Fig. 4), and is hypaxial from the vent to the end of the tail and then forward dorsally or epaxially; (Cœlacanthi, Placodermi, Dipnoi, Pleuracanthus). Another archaic trait is the perfectly straight chorda or vertebral axis which extends without upward curvature in typically diphycercal forms to the end of the urosome. (An archaic trait which also marks a phase of the ontogeny of the Teleosts is the Cœlacanthous—hollow—condition of the bony portion of the spines and their supports.) Fishes with a long eel-like body have tended to remain diphycercal, while those whose bodies have been abbreviated have tended, with the exception of such forms as the Heterosomata, to develop discontinuous median fins which have very probably been derived in the first instance, from hypertrophied portions of a continuous series. This hypertrophy in some cases involved the whole series, e. g., Platax. The primæval pre-diphycercal or lophocercal condition is mediately followed by the next stage (Fig. 5) which, as we have seen, must have been developed from a more archaic condition or one of true diphycercy. There therefore occurs a more or less extensive elision or failure to develop a continuous series of rays when specialization sets in so as to produce a discontinuous system of median fins. Embryonic development therefore fails to exactly recapitulate the phases of evolution of the median fins. Even the embryonic rays which are of mesoblastic origin do not always form a continuous series. They are far more numerous than the permanent rays, and are characteristic of the diphycercal condition and represent a stage of fin development which may be called the *protopterygian.*

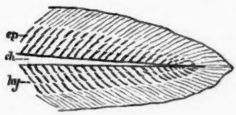


Fig. 4.

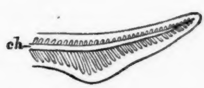


Fig. 5.

These views are fully substantiated by the development of the caudal skeleton of the eel, in which in spite of its slight hetero-

[1] Another article in the succeeding number will deal with the origin of the fin-rays.

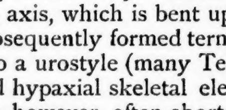
cercy the diphycercal continuity of the fin-series has remained practically unimpaired, thus affording the necessary proof of the *serial homology* of the entire series of median fin-rays and their intermediary supports. (Previous authors failing to attack this part of the problem by the light of the ontogeny of a diphycercal eel-like type have missed the solution of one of the most important minor parts of a rational theory of the median fins, since it is otherwise impossible to prove such a homology in forms with atrophied intervals between the vertical fins.) The mesoblastic skeletogenous tract from which the median fin-rays and their supports are developed, is continuous in the median line of the urosome, above, below and almost over the end of the chorda in fish embryos; such a continuity affords an explanation of why the median fin-rays form an uninterrupted series in cases of perfect diphycercy (Fig, 4), or where the archaic has not been replaced by a specialized mode of development, in the course of which discontinuity has arisen (Protopterus).

4. *Heterocercy.*—Heterocercy affects only the end of the chordal axis, which is bent upwards, and as a result of this it and the subsequently formed terminal vertebral segments are consolidated into a urostyle (many Teleostei), above and below which epaxial and hypaxial skeletal elements are formed, of which the former are, however, often aborted, and the latter widened as supports for the caudal system of rays.

This condition appears to result from two causes: (1) Great activity of growth in the terminal hypaxial part of the primitive caudal fin-fold in consequence of which the chorda is shoved upwards; and (2) from the *actions* of the animal in using the resulting expanded, hypaxial, caudal, ray-bearing fold in swimming; the strokes of the fin in action, owing to the resistance offered by the water, tend to throw up the somatic axis, just as an oar tends to be thrown upward in sculling.

Since the hypaxial fold may be developed at some distance from the end of the tail, in the more specialized forms (Lepidosteus, Fig. 6; Gasterosteus) a more or less extensively free portion

Fig 6.



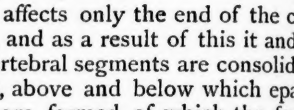


Fig. 7

of the lophocercal caudal axis is left to project (Fig. 7) during the growth of the true or secondary caudal, the rays of which are mostly hypaxial and serially homologous with those of the anal. The exserted part of the larval axis alluded to above, may be called the *opisthure*, in reference to its position in relation to

the permanent caudal. It subsequently degenerates, or it may persist as a prolongation of the chordal axis covered by integument, as in *Chimæra monstrosa* (Fig. 2) or, as in heterocercal Amiurus (Fig. 8), it may, at an early stage, have the chorda exserted beyond the last hypural cartilages and at some distance behind them have another hypaxial cartilage (*op*) developed, which may be called opisthural, as it probably represents the remnant of proximal hypural pieces, which were developed in some more primitive ancestral form in which diphycercy was more pronounced or even perfect. Where the caudal, ray-bearing finfold is developed nearer the end of the chordal axis (Apeltes, Siphostoma, Gambusia,) heterocercy is not so pronounced, as the urostyle is shorter and only one or two of the terminal vertebræ are involved, whereas in other cases (Salmo, Lepidosteus) more terminal vertebræ may be implicated by degeneration. In archaic forms of heterocercy there may be epaxial rays and intermediary supports developed, while the hypaxial supports and rays extend to the end of the upwardly bent termination of the axial column (Fig. 5). This trait may possibly differentiate the archaic type of heterocercy (Palæoniscus, Platysomus, Acipenser, Squali) from the more recent or specialized form (Amiurus, Fig. 8) now prevalent amongst Teleosts, and which have for the most part a more or less well-developed urostyle, but with a very short or included opisthure (= dorsal lobe, A. Agassiz), and with the epaxial spines of the urostyle displaced, rudimentary or aborted. Outwardly homocercal Palæozoic fishes (Dapedius, Pycnodus,) probably had an opisthural filaments developed during their larval stages which subsequently became aborted, as in Lepidosteus, but in others (Platysomus, Pygopterus,) the terminal part of the chordal axis doubtless became segmented, the segments bearing hypaxial caudal rays and few or no epaxial ones, so that their opisthures were probably rudimentary or wanting.

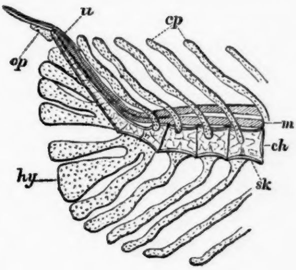


Fig. 8.

It thus becomes evident that the development of modern Teleosts presents only a partial or inexact parallelism with that of the Palæozoic Rhomboganoidei, for few, if any, of these forms show the urostyle so distinctly developed or the hypural pieces so extensively coössified as in existing Teleostei, and we have also shown that there is no such thing even as an exact parallelism to be discovered between the development of the tail of the embryos of the latter and that of the embryos of an existing representative of Palæozoic forms, viz., Lepidosteus (Fig. 6). The Rhom-

boganoidei, Cycloganoidei, Crossopterygia and Chondrostei show a more decided tendency towards the development of a dorsal and ventral, or, only a ventral series of caudal rays which extend to the end of the caudal axis, and thus trend more towards a diphycercal condition than the existing Teleostei, which may be said to be verging towards *hypocercy* when all of the caudal rays will be of hypaxial origin, with very often a rayless interval between the last hypaxial pieces and the end of the exserted urostyle (Fig. 8), the latter finally tending to become shorter and be aborted as in Fistularia and Apeltes. These are some of the marks of progress which distinguish the Teleosts and supplement the significant fact of their well-ossified skeleton. It is highly probable that we shall find no remains of the larvæ of Palæozoic fishes in the rocks, so that we have no means of contrasting their early phases with those of existing forms, but it is certain that none of the most simple forms of the Palæozoic fishes, in respect to their caudal skeletal structure, even approximate such a primitive condition as the lophocercal stage of modern forms; the only trait which they possess in common are the continuous median fins; in the first instance containing rays, in the latter case being without them. When we know the larvæ of Ceratodus, Polypterus, Lepidosiren and Protopterus, as well as we know that of Lepidosteus we may have a moderately comprehensive understanding of the main features of the development of Palæozoic fishes.

The evidence in favor of degeneration of portions of the caudal region of fishes is the existence of a permanent archicercal opisthure in *Chimæra monstrosa* and *Stylephorus chordatus*; the extensive development of a temporary opisthure in Lepidosteus; the concrescence of the hypural pieces; the ventrally diplacanthous and even triplacanthous caudal vertebræ (Fig. 8), or their coalesced representative, the urostyle; the existence of hypaxial opisthural elements; the abortion of the epaxial spines of the caudal vertebræ, and finally the abortion or extreme modification of the last muscular somites of the caudal region.

5. *Homocercy.*—This merely expresses the condition of epaxial and hypaxial symmetry presented by the fan-shaped caudal of Teleosts, and is the final term in the evolution of the growth of the rays of that fin, in consequence of which the archaic symmetry of perfect diphycercy becomes again restored, though the axial structure of the tail is heterocercal.

6. *Gephyrocercy.*—This type of tail appears to be normally met with in only two forms of Teleosts, viz., Mola and Fierasfer. The primitive opisthure or end of the urosome in these forms is apparently aborted, in the first, in the course of larval existence, in the other during post-larval life. As a result of this a hiatus is left between the epaxial and hypaxial rudiments of the median fins, and in the center of this hiatus the axial column ends

abruptly as if cut or bitten off, the hinder hypaxial and epaxial tissues concerned in the formation of rays and their supports are then approximated over the end of the aborted axis so as to form a continuous chain, and developed later than the other and more anterior median fin-rays (Mola), and the interval so bridged by a secondary process of development leads to the formation of what we may call a gephyrocercal tail, in which the spinous axial apophyses of the caudal vertebræ, together with their centra, fail to develop, and the caudal rays rest either upon interspinous elements alone, or even these may be almost entirely aborted, as is the case for a time in the young stages of Mola "*Ostracion boöps*" and "*Molacanthus*," both of which are evidently young, post-larval phases of that form.

The views here outlined rest partly upon facts of my own observation, but I must express my great indebtedness to the researches of L. and A. Agassiz, Vogt, Lotz, Balfour, Parker, Huxley and Kölliker, whose labors have enabled me to coördinate the facts and establish doctrines respecting the origin of the median fins, which are founded upon the theory of ontogeny.—*John A. Ryder. Nov. 3d, 1884.*

EXPLANATIONS OF FIGURES.

FIG. 1.—Larval Branchiostoma, (after Kowalevsky); almost perfectly archicercal.

FIG. 2.—*Chimæra monstrosa*, with an archicercal opisthural filament, (after Agassiz).

FIG. 3.—Lophocercal larva of the codfish, with continuous median fin-fold, *f f f f*.

FIG. 4.—Ideal diphycercal tail, nearly as in Ceratodus and Protopterus.

FIG. 5.—Ideal archaic heterocercal tail, somewhat as found in sturgeons and sharks.

FIG. 6.—Heterocercal tail of larval Lepidosteus (after Balfour and Parker), showing epural and hypural pieces undeveloped at the end of the chorda.

FIG. 7.—Tail of a very young Lepidosteus (from the same source), showing the opisthure, *op*, above the secondary or true caudal, *sc*.

FIG. 8.—Caudal skeleton of a larval Amiurus, fifteen days old. *op*, opisthural, *hy*, hypural, and *cp*, epural cartilages; *u*, urostyle; *m*, medulla spinalis; *ch*, chorda, invested by the skeletal tissue, *sk*, of the caudal vertebræ.

PHYSIOLOGY.[1]

THE THERAPEUTIC EFFECTS OF OXYGEN AND OF OZONE.—It is a popular error that breathing pure oxygen would prove destructive to animal life by greatly accelerating combustion in the body as it does of the fuel of an ordinary fire. Filipow has lately submitted the question of the physiological action of oxygen and ozone to exact experiment on men and dogs; his results may be summed up as follows: 1. Breathing pure oxygen is followed by no effects which distinguish its action from that of pure atmospheric air, at least as regards pulse, respiration and body temperature. 2. In cases of poisoning with chloroform, alcohol, sulphuretted hydrogen or carbonic oxide, respiration of pure oxy-

[1] This department is edited by Professor HENRY SEWALL, of Ann Arbor, Mich.

gen offers no advantages over that of pure air. 3. Breathing in diluted ozone is without the narcotizing effects which some ascribe to it. 4. Respiration in concentrated ozone produces powerful irritation of the mucous membrane, and is therefore injurious. 5. There is no proof that ozone is taken into the blood through the lungs.—*Pflüger's Archiv., Bd. 34, S. 335.*

The Presence, Source and Significance of Sugar in the Blood.—Seegen publishes an interesting contribution to the much discussed question of the function of the liver in relation to carbohydrates. As is well known, Bernard and his followers regarded the liver as the sugar-making organ, and went so far as to maintain that the sugar thus formed was produced chiefly by the disruption of albuminous material. Pavy and others regard, in general, the liver as a sugar destroyer, by whose means the overloading of the blood with absorbed carbohydrate is prevented. Seegen lends his support to the older school. He shows that sugar formation in the liver is a general physiological function shared by widely different groups of animals, herbivorous and carnivorous. He finds, moreover, that the liver, even when excised, has the power of producing sugar from peptone. Numerous researches on dogs gave the following principal results: 1. Sugar is a normal constituent of the blood, but varies in its proportions from 0.1 per cent to 0.15 per cent. 2. The sugar content of the blood in the right and left sides of the heart is the same. Differences between the proportion of sugar in arterial and venous blood are not constant but variable within narrow limits. The blood of the portal vein, however, nearly constantly contains less sugar than that of the carotid artery. 3. The blood which leaves the liver contains double the quantity of sugar held by that entering it. The mean of thirteen experiments gave for blood of the portal vein, sugar 0.119 per cent; for the hepatic vein, sugar 0.23 per cent. 4. The amount of sugar thus leaving the liver in the course of a day is very considerable. The amount produced by the dog's liver in twenty-four hours is calculated to vary from 200 to more than 400 grammes. 5. The blood-sugar is formed, at least in carnivorous animals, exclusively from albuminous bodies. 6. The sugar content of the blood rapidly diminishes when the liver is excluded. This sugar is used up in all the living tissues.—*Pflügers Archiv, Bd. 34, S. 388.*

The Prevention of Hydrophobia.—MM. Pasteur, Chamberland and Roux have made the following communication on the prophylaxis of rabies by inoculation with a modified virus. They find (1) that the virus transferred from the dog to the ape, and cultivated by propagation through several members of the latter order, becomes progressively feebler after each inoculation. After a certain period of such cultivation, if it be hypodermically administered to dogs, guinea-pigs or rabbits, or even by intracra-

nial injection (the most deadly method), death does not result, but the animal acquires an immunity from hydrophobia. (2) If, on the other hand, the poison of rabies be cultivated in successive rabbits or guinea-pigs only, its potency is intensified, and after a time is so great that a fatal issue invariably follows its inoculation. The poison as found in the dog is intermediate in strength between that of the two methods of cultivation just mentioned. Thus by careful selection of the medium and the stage of cultivation, it is possible to accumulate a store of attenuated virus which can be relied on to communicate a modified rabies whose inoculation shall be protective against its severer forms, as that of vaccinia is against variola. There is also good reason to believe, though the actual experiment is postponed, that, as with vaccinia, the modified poison hypodermically engrafted immediately after the bite of a rabid animal, will forestall, by the speed of its development, the symptoms due to the bite. No experiments have as yet been made on the human subject. (*Progrès Médical*, May, 1884). The experiments which M. Pasteur is reported thus far to have made are said to be an unbroken success. Fifty-seven dogs have been the subjects of investigation. Of these, nineteen were rabid, and by these, thirty-eight healthy animals were bitten under uniform conditions. Of the thirty-eight, one-half the number had been previously inoculated or "vaccinated" with attenuated virus, the other half had not. The latter, without a single exception, died with unequivocal signs of rabies, whereas the nineteen others remain as well as ever. They will be watched for a year by veterinary surgeons to see whether the inoculation holds good permanently or only temporarily. If rabies be not spontaneous in its origin, and if the experiments of Pasteur all turn out successful, there seems no reason why canine madness should not be extirpated from our midst.—*Lancet, July 12, 1884.*

PSYCHOLOGY.

Clevenger on the Evolution of Mind and Body of Man and Animals.[1]—We have here a work, scientific and speculative, on several of the live questions of the day. The author is an evolutionist physical and metaphysical. More than this, he is a mechanical evolutionist, and endeavors throughout the book to prove the origin of structures through use and effort, and their loss by disuse. The especial object of the discussion is to demonstrate the origin of mind and its various departments by the action of its material basis. From this process he does not exclude consciousness as a necessary factor. When he comes to the origin of consciousness, the author writes as follows (p. 18): "The amœba's functions are simple, but nevertheless the same as

[1] Comparative Physiology and Psychology, by S. V. Clevenger, M.D., Chicago, Jansen McClurg & Co., 1885, pp. 247.

our own. Forthwith we must assign it a desire for food, which desire is the chemical affinity of atoms; then the Amœba hungers." The origin of movements under the stimulus of pain and pleasure is next followed out. The reproductive instinct is referred to as a modified form of hunger. There is also a theory of the origin of the brain; and another as to the origin of the differentiation between the motor and sensory nerves and their functions. The work is a brilliant one, and is studded with epigrammatic sentences, some of which have points which will be felt, but whether pleasurably or painfully will depend on the opinions of the reader. For instance; "Sociologically the money-grubber devours the services of men of brains, and the issue of the business is the development of faculties and facilities for mercantile improvement both in the sordid and mental aspects." Again: "A Chicago writer dislikes to credit any one in Arkansas with a good thought. A New York or Boston man cannot conceive of Chicago originating anything, and across the sea the general run of scientists avoid any mention of America or its workers if possible. Darwin was a notable exception to this rule, for he was above pettiness." The author has ransacked the literature of his subject, and has made a most interesting book.

The writer undervalues metaphysics, which he calls "lunar politics." Hence his identification of consciousness with chemical affinity (see above on hunger). This is a fundamental point in the science of mind in the large sense, though it may not greatly affect theories of the evolution of the human mind out of consciousness with the aid of memory and molar motion. We have already explained in this journal (1884, p. 973, on Catagenesis) and elsewhere the opposite doctrine, that consciousness is not a form of energy, but that although inseparably bound to matter and energy, it is coëqual with them. Some reasons for this view may be restated as follows:

When a form of energy is developed (as heat, light, etc.), which was not present before, we know, in accordance with the law of the conservation of energy, that the energy was already present in some other form. We thus get something out of something. We cannot hold the same view when consciousness appears where it had not been before. It is like the attempt to add beans and potatoes to get apples, etc.; in a word it is an attempt to get something out of nothing. To look upon it as a *product* of the metamorphosis of energy is like regarding a man as the product of the door which is opened in order to admit him to sight. None but a savage could entertain such an opinion. In view of the nature of the case, as well as of the truths of Kinetogenesis, so well presented by Dr. Clevenger, it is much more logical to believe that the consciousness is derived from an outside source, and is communicated to matter which is in a proper energetic state. The difficulties in the way of this view are largely if not

entirely removed by the well-known facts of *discontinuous consciousness.* There is a form of brain malady in which persons whose consciousness is clearly continuous to outside observers, lead two or more distinct conscious lives, the one of which knows nothing about the other. This is caused by the *abolition of the memory* of a part of the conscious existence. Now it is far more probable than not, that in a transfer of consciousness from one physical basis to another, the molecular structure which is the condition of memory is lost in whole or in part. Hence the absence of prenatal memory. If the mind ever learns of its forgotten life it must be by a process of exploration and unraveling of records. Such a research would be a palæontology of mind, and its materials are doubtless as abundant in the universe as are the records of the physical organisms which we now excavate from the rocks.—*E. D. C.*

A Horse's Memory.—Our sagacious little family horse—"Joe" —was kept at our place a few weeks one winter several years since, and then taken back to his owner, thirty-five miles away. Twenty-one months later I purchased him. He was led to town by the stage-driver, where I received him a mile and a half from my farm. I saddled and mounted him and told him to "go," leaving him, however, to take his own course, with a view to seeing whether he remembered the way home. Several turns were to be made in the village streets in getting out of town, but Joe made every one as correctly as he would to-day, after having traveled the same little journey daily for years. We finally crossed a bridge over Boone river, at the west end of which a gate opens into a grove, the house being forty or fifty rods off to the north. Joe stopped at the gate of his own accord, waiting for me to dismount and open it. He seemed to know every rod of the way, both to the barn and the stable, though he had been away about a year and nine months. He was a little disconcerted, however, upon going into the stable, appearing lost for a moment, but the cause of his embarrassment was sufficiently apparent from the fact that the stalls had been changed to the opposite side. It was perfectly clear, however, that he had not forgotten a single detail of his daily life during his first brief sojourn with us.—*Charles Aldrich, Webster City, Iowa, Nov. 21, 1884.*

Training Elephants.—African elephants, said Forepaugh to a reporter, are more intelligent, imitative and cunning than the Asiatic. In training elephants the best method is to win them over by petting and feeding them with something nice. I always have a cake or some delicacy to give one of them when I take him out for practice, consequently the beast is always glad to see me, and is more attentive and docile than he otherwise would be. Elephants never forget anything—they recollect "their stage business" and "situation," and do not vary an inch one evening

from another in taking their positions. It requires about five months to train an elephant. We practice from 6 o'clock in the morning until 6 o'clock in the evening. They are drilled singly, and then in squads, and then taught their various "specialty" acts and tricks. Elephants are more imitative than any other animal perhaps, and are very cunning. While practicing they are looking out for an opportunity to "cut up," and will reach back and kick the trainer, and then look as innocent as a truant school-boy. They seem almost human enough to talk. The importation of elephants has increased tenfold within the past decade. Ten years ago very few circuses had more than three or four elephants, and one was the usual number; now, no circus is complete without fifteen or twenty.—*Exchange.*

The Chimpanzee in Confinement.—At the Zoölogical Gardens, Philadelphia, are two interesting individuals of this species. Although they are comparatively young, perhaps not older than six years, yet they have an extremely antiquated appearance. I heard a countryman say to a bystander that he "guessed they were 70 years old, easy." One of them has such a great fondness for an old blanket that he carries or drags it with him wherever he goes. Even if he desires to climb to the extreme top of his cage, the blanket must go along, although it greatly retards his progress. He knows its use, but does not always use it judiciously. Thus, on an oppressively hot day in July, I have seen him reclining for twenty minutes or more, entirely enveloped in the blanket, with the exception of his face, looking at the spectators with a comical and pouting expression. I saw one, when teased and disappointed by its keeper, throw itself upon the floor, and roll and scream vehemently, very like a naughty child in a tantrum. A board shelf was placed across their cage for them to climb upon. This they soon found could be used as a spring-board, and nothing seems to give them more pleasure than, when there is a good audience, to steal gently to the center of the board, grasp it tightly with all fours, and spring violently up and down, causing the board with themselves to vibrate rapidly, and producing at the same time a loud, jarring noise. They then seem to greatly enjoy the startled and amused looks of the spectators. Perhaps one of their most human actions is languidly to recline, and holding a straw in one hand, listlessly to chew at its tip, while the eyes are rolled vacantly around. It may be that they are then building "castles in Spain." —*C. F. Seiss, in Scientific American.*

ANTHROPOLOGY.[1]

The Precursor of Man.—At the meeting of the French Association at Rouen, last year, the section of anthropology made an excursion to Thenay, near Blois, to study the question of Tertiary man. The digging was performed under the direction of

[1] Edited by Prof. Otis T. Mason, National Museum, Washington, D. C.

MM. d'Ault-Dumesnil and F. Daleau. In a small volume, prepared by le Marquis de Nadaillac, and distributed among the members, entitled: "Notice sur Blois et les environs;" a chapter of fourteen pages is devoted to the silex of Thenay. In greeting the congress M. le Senateur Dufay discarded the term "Tertiary man," and spoke without apology of the *Anthropopithecus*, a name invented by M. G. de Mortillet. The succession of beds, as revealed by Abbé Bourgeois, is as follows:

A. Vegetable mold	0.60^{m}
B. Shell marl, mass of marine fossils	0.40
C. Beds of fresh-water calcareous deposits, with Pholas excavations in the upper portion	0.32
D. Fresh-water white marls, foliated, flint rare	0.75
E. Bed of fresh-water limestone	0.25
F. Marls as in D, silex rare	1.15
H. Bed of clay, with calcareous nodules and bones of Acerotherium	0.24
I. Marls as in D, silex rare	0.92
K. Foliated marls, darker and containing numerous flints broken and retouched	0.60

The flints brought to light reveal not only the effect of working, but the influence of fire. This past phenomenon M. G. de Mortillet discusses at length, in l'Homme, 1884, p. 550. Now with these facts clearly stated the next duty is to study them dispassionately. The *Anthropopithecus* must be fairly treated. On the one hand there is nothing sacred about him, and he may have to be knocked on the head; on the other hand, he is not, *per se*, as a rival of "Tertiary man," to be hustled off the wharf.

INTERNATIONAL GEOGRAPHICAL EXPOSITION.—At the seventh National Congress of French Geographical Societies to be held in Toulouse in next August, will be organized an international exposition, of which the fifth section relates to anthropology. M. E. Cartailhac will have charge of this section, of which the following is an outline:

I. *Anthropology.*— Crania, skeletons, tissues; figures and busts, especially with reference to races.
II. *Demography.*—Statistical studies of peoples; graphic methods, charts, copies of works.
III. *Prehistory* —Human remains, relics; charts, books, objects, prints, *et similia.*
IV. *Ethnology.*
V. *Glossology.*
VI. *Instrumentalities*, of research and instruction.

Considerable space has been given to these programmes because the time has come to give to our science a more restricted definition in the use of terms and the classification of objects. In other words, we ought to know what terms to apply and what arrangements to make of our specimens, to exhibit and to describe them. The NATURALIST will open its anthropological department for the discussion of these two ideas, the meaning of words and the best methods of classifying. The last point will include the number and relative importance of classific concepts as well as the method of separating and studying materials.

TURNER'S SAMOA.—Readers of books often wish that authors would so concentrate their writing as to tell just what we want to know and not one word more. This is unreasonable; but, on the other hand, most authors write a great deal that is never quoted by anybody. Twenty-three years ago George Turner published his celebrated work, Nineteen Years in Polynesia, in which he mingled his experiences as a missionary with accounts of the natives that our greatest anthropologists were never tired of quoting. In the volume now before us the ethnographic matter has been extracted, much new matter has been added, and the whole has been so arranged and indexed as to constitute a text book on Polynesia of the highest order. Dr. E. B. Tylor endorses the work in an appreciative preface. The first two chapters relate to the Samoan group and the traditions of their origin and names; the third, fourth and fifth to the religion and the gods of the natives. The rest of the chapters take up the general subject in the following order. The people: infancy, childhood and adult years; food, cooking, liquors; clothing; amusements; mortality, longevity, diseases; death and burial; houses; canoes; articles of manufacture; government and laws; wars; the heavens and heavenly bodies; origin of fire and other stories; names of the islands illustrating migration; political divisions; ethnological notes on Bowditch, Humphreys, Mitchell, Ellice, Tracey, De Peyster, Spieden, Hudson, St. Augustine, Rotch, Hurd, Gilbert, Francis, Netherland, Savage, New Hebrides, Loyalty, New Caledonia and New Guinea islands. One hundred and thirty words are given in the following fifty-nine languages: Marquesas, Tahiti, Hawaii, Raratonga, Manahiki, Samoa, Niué, Fakafo, Tonga, Bau, Rotuma, New Zealand, Aneiteum, Niua, Tanna, Eromanga, Vaté, Nengone, Lifu, New Caledonia, Ebon, Moreton bay, Malayan, Javanese, Bouton, Salayer, Menado, Bolanghitano, Sanguir, Salibabo, Sulu islands, Cajeli, Mayapo, Massaratty, Amblaw, Tidore, Gani, Galela, Liang, Morella, Batumerah, Lariko, Saparua, Awaiya, Caimarian, Teluti, Ahtiago and Tobo, Ahtiago, Gah, Wahai, Matabello, Teor, Mysot, Baju, Dorey, Pt. Moresby, Madagascar.

Whatever other book the ethnographer may have to do without, he cannot afford to deprive himself of this concentrated treatise.

SNAKE DANCE OF THE MOQUIS.—Three years ago, that prince of collectors, Col. James Stevenson, sent to the National Museum a large collection of rudely-carved and painted dolls, wands, head-gear, blankets, rattles and other paraphernalia relating to the Moki sacred dances. Following him, Mr. Cushing, who understands very well the purport of these objects, mounts them for the great exposition at New Orleans; and to cap the climax, Captain John G. Bourke, U.S.A., writes a charming book describing the manners and customs of the Moki, their seven

communal towns perched upon the mesas of Northeastern Arizona, and relates with great minuteness his attendance upon the snake dance, a rite which seemed revolting even to the enthusiastic narrator. Everybody should read the book. We do not know which to praise the most, the author for shaking off the lethargy of camp life and gathering the material, the happy, often frolicksome style in which the work is written, or the beautiful illustrations which throw so much light upon the text. We have only space here to say that in the month of August every year the Moki celebrate a snake dance. Eight days before the dance the young men go north one day, west one day, south one day, east one day, and the other four days they roam all over the country, if necessary, to catch the snakes, using all kinds. These reptiles are placed in an estufa until wanted, kept in order by certain old men who have no other weapon except a small stick, at the end of which are two eagle feathers. The snakes are afraid of the birds of prey, and seem to have a wholesome dread even of their feathers. After the most elaborate preparation, witnessed by Captain Bourke, the dancers march through the principal streets, certain of them carrying each a squirming snake in his mouth, the animal being kept in order by a companion using the eagle-quill teaser. The closing chapters of Captain Bourke's volume are devoted to the daily life and customs of the seven Moki towns.

Why Tropical Man is Black.—Dr. Nathaniel Alcock contributes to *Nature* a very interesting paper in which he argues that light and actinism have coöperated with heat in the coloring of the skin. If man could live by heat alone, in the tropics the black man would be fittest, because he would be the hottest. But light has also played such an important part that those in whom a portion of the rays of the glaring sun are blocked at the surface are best adapted for survival beneath its vertical beams. The waves of light and heat follow each other at similar rates through the luminiferous ether. When light or heat impinges on man its waves select those atoms whose periods of vibration synchronize with their own period of recurrence, and to such atoms deliver up their motion. It is thus that light and radiant heat are absorbed. Heat waves thus notify their existence along the surface fiber to the central nerve cell, and so enable the animal to avoid their action, if excessive, or seek their increase if deficient. While heat waves are thus received and responded to, their fellow workers, the waves of light, are not inert.

Admitting that theoptic nerves are but nerves of the skin, whose molecules once could vibrate only with the large ultra-red waves of heat, it must be conceded that in the first instance all surface nerves must have felt the influence of that agent by which they are to be hereafter exalted. But a yet more wondrous lesson is to be learned from the steps which nature takes for the

exaltation of a heat-responding nerve into one capable of vibrating in harmony with the shorter waves of light. In the *Euglena viridis* a colorless and transparent area of protoplasm lies in front of the pigment spot, and is the point most sensitive to light. Progressingupward we ever meet with the same arrangement, transparency immediately in front of the part to be exalted, and pigment immediately behind it.

Nature has made the most of her two factors by exposing the selected tissue to the continued impinging of waves of light, at the same time securing not only the transmission through it of the waves of heat, but their constant accumulation behind it, thereby causing the molecular constituents of the protoplasm to be thrown into the highest rates of vibration possible with the means at disposal.

Recognizing the effects of simultaneous light and heat when their influence is concentrated, by a local peculiarity, on a particular part, must it not be evident that in an individual unprotected by hair and unscreened by clothes, living beneath the vertical rays of an equatorial sun, the action of these two forces playing through a transparent skin upon the nerve endings over the entire surface of the body, must be productive of intense, but at the same time disadvantageous nerve vibrations, and that presumably such individuals as were least subject thereto would he best adapted to the surroundings. Nature having learned in ages past that pigment placed behind a transparent nerve will exalt its vibrations to the highest pitch, now proceeds upon the converse reasoning, and placing the pigment in front of the endangered nerve reduces its vibrations by so much as the interrupted light would have excited, a quantity which, though apparently trifling, would, when multiplied by the whole area of the body surface, represent a total of nervous action that if continued would soon exhaust the individual and degrade the species.

Thus it is that man still retains in its full strength the color of skin which, while it aided him materially in his early escape from his enemies, is now continued because it has a more important office to fulfill in warding off the millions of vibrations a second which would otherwise be poured in an uninterrupted stream upon his exposed nervous systen.—*Nature, Aug. 21, '84.*

MICROSCOPY.[1]

Modern Methods of Microscopical Research.—Microscopical technique has made such rapid progress in the last few years that it has been found necessary to supplement our hand-books of methods through the publication of special journals and departments of journals which undertake to bring together the latest discoveries and improvements. A new and very important line of

[1] Edited by Dr. C. O. Whitman, Mus. Comparative Zoology, Cambridge, Mass.

work has thus been started, and this work is destined to grow rapidly in general importance and interest. It may be worth while to consider briefly the character and the urgency of such work, and to suggest how its aims can be promoted by those who are actively engaged in the various fields of microscopical research.

The microtome has come to occupy a place in the zoölogical laboratory second in importance only to the microscope itself. Many improvements in details and in accessories have followed the introduction of this instrument, and a whole series of methods has sprung up in connection with its use. In short, we have a new art which has been appropriately called *microtomy.*

The general favor with which the microtome has been received is the best evidence of its usefulness. There ought no longer to be any place for prejudice or indifference in regard to its merits. The use of the instrument is so simple and the methods connected with it so easily acquired that no naturalist can afford to work without it.

It is not enough to possess a microtome and to be master of its simpler uses; the working naturalist should have the best, or one of the best instruments in the market, and it is important that he should have the earliest information of any improvements attending its use.

Within the last four or five years the improvements and discoveries in microtomy have been both numerous and extremely important. Among these may be mentioned the ribbon method of cutting serial sections, discovered by Caldwell; the methods of fixing sections on the object-slide, discovered by Giesbrecht, Schällibaum and Mayer; the various section-smoothers, notably those invented by Mayer, Andres, Giesbrecht, Schulze and Decker; the use of collodion to prevent the crumbling of brittle sections, proposed by Mason; and the methods of reconstructing objects from serial sections employed by His and Born. A large number of new preservative and staining fluids have been described; and new methods of killing, hardening, preserving, staining and imbedding have been recommended. The rapid development of methods is at once the result and one of the chief causes of the increasing activity in every field of biological research. The improvement of methods leads to the re-investigation of old subjects, and at the same time prepares the way for attacking new problems. The investigator who neglects to keep himself informed of the progress in methods of study, throws away his opportunities, and has the vexatious mortification of seeing himself outdone and his work superseded by that of more skillful hands.

So much depends on successful methods of preparing objects for investigation, that naturalists are now expected to state precisely how their results have been obtained. But the methods

are usually given with the investigations themselves, and are therefore scattered about in different journals and isolated publications; hence arises the necessity for some sort of repertory in which the stray accounts and straggling items may be gathered and summarized. The department of microscopy will make this work its special concern. The necessity for immediate information makes it impossible to avoid a more or less chaotic presentation of subjects, and reviews of progress in special directions will therefore be in order from time to time.

There is another feature of the work proposed in this department to which we wish to invite particular attention. Experience has shown that each different object requires a special mode of treatment, and that the same object must be treated differently according to the nature of the problem in hand. For example, the course of preparation which has given satisfactory results in the study of the development of the ova of a certain species, may prove quite inadequate when applied to a different though closely allied species. And it has been found that different stages in the development of the same ovum often require different modes of preservation. The investigator cannot, therefore, blindly adopt the methods employed by others, but must, in by far the greater number of cases, determine by experiment the method to be pursued. But such experiments demand a general knowledge of methods, and, above all, a knowledge of the special applications of methods in cognate subjects. It is in the adaptation of methods to special subjects that the skill of the investigator is shown. Our information of the methods employed in specific cases should be as extended as possible. To meet this need entire courses of methods that have led to successful results in typical cases will continue to find a place in this department.

Such then are the aims of "microscopy." If those who take an active interest in the cultivation of microscopical methods desire to further these aims, they can do so, and at the same time confer a favor, by communicating to the editor any information respecting methods which they have found useful, or by sending published accounts of important methods for review in these pages.

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SCIENTIFIC NEWS.

— The winter session of the Teachers' School of Science connected with the Boston Society of Natural History commenced in October with a lecture on sponges, by Professor Alpheus Hyatt, who will conduct a course of ten lessons upon the structure of animals. The plan pursued by Professor Hyatt has special reference to the teaching of methods of observation. On. Jan. 3d will be commenced a supplementary course of ten practical laboratory

lessons in elementary mineralogy, to be given in the laboratory of the institute by Professor W. O. Crosby and Mrs. Ellen H. Richards. The class is limited to fifty teachers, one to be nominated by each of the masters of the Boston grammar schools.

— The Biological School of the University of Pennsylvania was opened on Nov. 3d. Professor Harrison Allen delivered the opening address. He outlined the objects of the school in a masterly manner, pointing out that original research is its leading aim. It is to be hoped that Professor Allen's views as to its conduct will be carried into effect, otherwise it will become a school of instruction only, and as such an unnecessary addition to the general university course. In order to do this its chairs must be filled by original investigators.

— *Limulus polyphemus*, the horse-shoe or horse-foot crab, as it is called in New Jersey, in whose flat sandy bogs it lives in immense numbers, is becoming useful as food for fishes. Enormous numbers are fed to eels, which greedily devour them. In one pond they were said to consume seven hundred and fifty horse-feet in three days. It would seem impossible to furnish so many, but the number does not begin to detail the extent of the catch. Millions of them are annually fed to swine and poultry, and some men make a business of catching them. On June 15, after a storm, Captain Downs, with a trap of his own invention, caught one thousand "feet," and between the 15th of July and April his aggregate catch was nineteen thousand.

— The St. Louis Academy of Science and the Missouri Historical Society according to the Kansas City *Review of Science*, have finally gained the property which has been so long in litigation and will probably at once erect a building suitable for the purposes of both bodies. The property was given by the late James H. Lucas, a number of years ago, but the delivery was refused by his heirs on account of delay in complying with the terms of the grantor.

— James Macfarlane, Towanda, Pa., is preparing a second and much improved edition of his Geological Railway Guide, and wishes persons who have used the book to send him corrections and additions. If it will be a saving of labor, they may send him their copies of the book containing such notes by mail, which he will return refunding the postage.

— The French Association met at Blois, as announced on the 3d inst. One of the most interesting subjects of the sitting was the examination of the Thenay geological strata, where Abbé Bourgeois thinks he has discovered Tertiary man. The principal French geologists arrived in Blois for the excursions, but there were very few foreigners.

—Among the faculty of Bryn Mawr College for ladies, to be opened next year near Philadelphia, we notice the name of

Dr. Edmund B. Wilson, late lecturer on biology in Williams College and author of zoölogical essays of sterling value. The standard of science-teaching in our American colleges is steadily rising.

— The *Naturæ Novitates*, published during the last six years every fortnight by R. Friedländer & Sohn, at Berlin, is sold for a dollar a year, and proves a useful bibliographic list of current literature of all nations on natural history and the exact sciences, with brief news items, which we find of occasional use.

— The meeting of the German naturalists and physicians was opened September 18, at Magdeburg; over a thousand members were present. The association will meet next year at Strasburg, with Professors Kussmaul and De Bary as secretaries.

— Professor Dr. Arnold Foerster, the well known hymenopterist, died at Aachen, Aug. 13. He was a school-teacher, and we well remember his courteous greeting when we called on him twelve years ago.

— Alfred E. Brehm, the author of Illustrirtes Thierleben, and well known as a traveler, died in November last; he was born in 1829. Dr. L. Fitzinger, the well-known zoölogist of Vienna, died Sept. 22.

— We regret to notice that *Science Record*, of which two volumes have appeared, published by S. E. Cassino & Co., and edited by Mr. J. S. Kingsley, ceased to exist with the December number.

— The next meeting of the Society of Naturalists, E. U. S., was to be held at Washington, D. C., during the week following Christmas, 1884.

— The late Sir Erasmus Wilson's munificent bequest to the Royal College of Surgeons is expected to reach the sum of £200,000.

— On July 25, 1884, died in London George B. Sowerby, known as a conchologist and palæontologist. He continued the Thesaurus Conchyliorum begun by his father.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Biological Society of Washington, Nov. 29, 1884.—The following communications were presented: Mr. Sanderson Smith on the recent deep-sea explorations of the United States Fish Commission, with special reference to geological results; Mr. Leonard Stejneger exhibited specimens illustrating the shedding of the bill in auks; Dr. George Vasey on the grasses of the arid plains; Mr. Charles D. Walcott on the oldest known fauna on the American continent; Professor Lester F. Ward on the occurrence of the seventeen-year locust in Virginia in October, 1884.

NEW YORK ACADEMY OF SCIENCES, Nov. 10.—The following paper was read: Elephants, ancient and modern, with reference also to the extinction of the mammoth; and notes on the small elephants lately brought to this city from farther India (with lantern illustrations), by Professor H. L. Fairchild.

Dec. 1.—The paper of the evening was Iroquois customs and language, by Mrs. Erminnie A. Smith.

BOSTON SOCIETY OF NATURAL HISTORY, Nov. 5.—Mr. S. Garman exhibited a novel type of flounder; and Mr. John M. Batchelder spoke of the lamprey as a builder.

Dec. 3.—Mr. F. W. Putnam gave an account of the explorations of ancient earthworks in Ohio, made during the past season by Dr. Metz and himself for the Peabody Museum.

AMERICAN GEOGRAPHICAL SOCIETY, Nov. 10.—Lieutenant Shufeldt, U. S. Navy, delivered a lecture entitled, Madagaskara: the land of Sinbad, the sailor; a journey of exploration across the great African island (illustrated with twenty-five stereopticon views from original photographs taken by the lecturer).

APPALACHIAN MOUNTAIN CLUB, Boston, Nov. 12.—The reports of councillors was presented, and Mr. Samuel H. Scudder read a paper entitled, The Alpine Club of Williamstown, Mass.

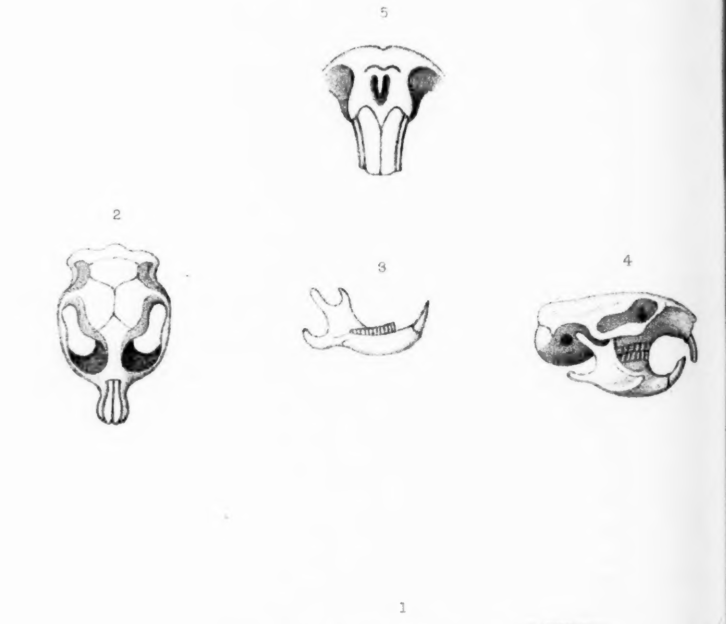
PHILADELPHIA ACADEMY OF NATURAL SCIENCES, May 1.—No less than fifty distinct species of sponges from Florida were presented by Mr. Jos. Willcox. This gentleman remarked that the limestone of the peninsula is eroded into numberless caverns, and is full of sinkholes, yet when exposed it is hard and in some localities marble-like. He believed that sea-urchins cannot have protection in view when they cover themselves with sea-weed, as they are more conspicuous thus covered. The common *Busycon pyrum* of the coast always deposits its eggs below the sand, attaching the egg-cases to a shell at least eight inches below the surface. Two mollusks, *Fasciolaria tulipa* and *Melongina corona*, break holes in the shields of king-crabs and eat out the flesh. Saw-fishes are abundant in shallow water, and it was observed that when they were speared they would turn up the saw and pull it repeatedly across the handle of the spear, soon making a notch. The sand of the beach is siliceous, and is probably derived from the mainland of Georgia. Mr. Potts stated that he had received several fine fresh-water sponges from the St. John's river, near Palatka. One of these he believed to be a new Meyenia, for which he proposed the name *subdivisa*. Mr. Ford reported the finding of *Pholas cuneiformis* in a billet of wood at Anglesea.

May 8.—Dr. Leidy exhibited fragments of a tapeworm widely differing from the tapeworms usually found in man, and probably

belonging to *Tænia flavopunctata*, a species observed but once before, when it was described by Professor Weinland. It is probably more common than might be supposed; its small size (fifteen inches or so in length) may have caused it to pass unnoticed, or it may have been confounded with other species.

May 16.—Dr. McCook gave the details of the mode in which *Lycosa riparia* forms its egg-ball; the spider (one kept in captivity) made an excavation and covered it with a thin sheet of silk; on the wall of her cave she then spun a cushion of white plush about three-fourths of an inch in diameter; in about half an hour the egg-mass was deposited and covered over with a layer of silk similar to that of which the cushion was composed; soon after the cushion had disappeared, and the round ball was dangling from the end of the spider's abdomen in the usual manner; as the spider has not excavated since, her evident object was to secure seclusion. The same speaker called attention to the discovery, by Mr. Alan Gentry, of spiders in full health and activity beneath the surface of the ice of a frozen pond; when found they were passing from point to point on lines stretched between water plants at a distance of eight or ten feet from the bank. Dr. Leidy exhibited specimens of *Pentastomum proboscidium* from the lungs of a Florida rattlesnake. Mr. Potts announced the discovery of great numbers of Cristatella in Harvey's lake, near Wilkesbarre. Specimens six inches long were found. In traveling they did not follow the sinuous course usual in the genus. The colonies have a persistent non-polypiferous appendage. As a provisional name he proposed *Cristatella lacustris.*

May 22.—Mr. Willcox stated that shell-mounds abound on the west coast of Florida. A portion of the town of Cedar Keys is built on such a mound. Human bones, stone implements and fragments of pottery are frequently found among the shells. On St. John's island, at the mouth of the Cheeshowiska river, may be seen a former place of manufacture of stone implements. Professor Heilprin announced that in addition to the foraminiferous genera previously described (Orbitoides, Nummulites, Operculina, Heterosteginæ, Biloculina, Quinqueloculina) he had found Spheroidina in the rock-masses from Florida. He believed that none of the genera save Orbitoides had before been found in America. He had found a second species of Nummulites, also one or two additional forms of Orbitoides, one of which (*O. ephippium*) proves beyond doubt the Oligocene age of the deposits. Mr. Potts stated that a correspondent in Jamaica had failed to find a single fresh-water sponge. He said that in obstructed water pipes he could find no traces of sponge, but only clay with iron impregnation. The skeleton spicules of *Meyenia leidyi* undergoes degeneration in the presence of iron.



T. Sinclair & Son, lith. Phila.

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